MACHINERY

SEPTEMBER, 1913

MACHINING AUTOMATIC CHUCKING MACHINE AND LATHE TURRETS

SPECIAL BORING AND PLANER FIXTURES FOR INSURING HIGHLY ACCURATE INDEXING

BY C. M. CONRADSON*

IN boring the spindle bearings of the turret for the automatic chucking machine shown in Figs. 1 and 2, it was necessary to attain a degree of accuracy seldom required in machine work of this size. The holes had to be perfectly round, accurately spaced tangentially and radially, and the axes of the holes had to be exactly parallel with the axis of the central bearing of the turret. When it is known that the limit of tolerance was 0.0005 inch, it will be readily understood that this job required more than ordinary care.

In order to index the work for boring the six bearings, a special fixture was constructed which, so far as the writer knows, operates on a new principle. Referring to the illustrations, it will be seen that this fixture is mounted on a surface plate, the work being carried on an arbor supported in V-blocks. The supports which carry these V-blocks are firmly bolted and doweled to the surface plate and carefully

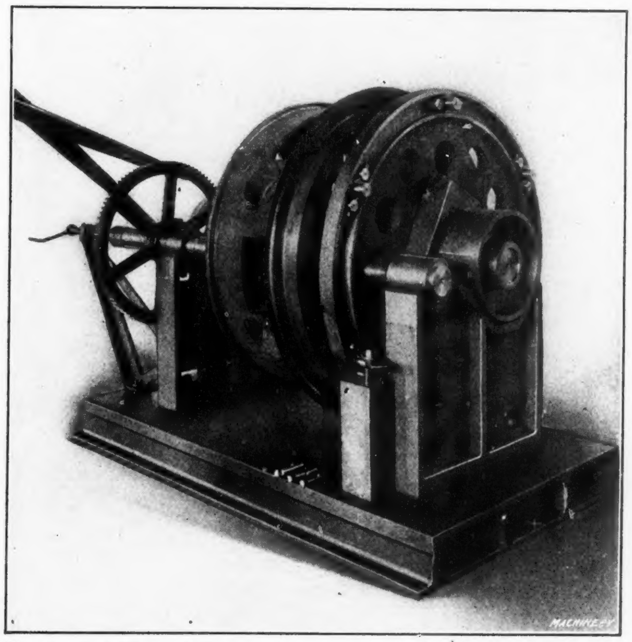

Fig. 1. End View of Fixture showing V-blocks and Indexing Mechanism

finished to bring the axis of the spindle carrier at exactly the required distance from the boring-bar which machines the six bearings.

The boring-bar is also supported in bushings which are carried in V-blocks, the bar being provided with double-ended boring cutters. The method of driving the boring-bar and feeding it up to the work is clearly shown.

The method of indexing used on this fixture constitutes the most interesting part of the work. The index wheel is a heavy plate casting which is clamped to the arbor by means of a split hub. It will be seen that there is an annular groove in the plate close to the periphery, and the index plugs are carried in holes bored through the casting in this groove. The plugs were very carefully ground and lapped after hardening and were brought to a perfect fit in the annular groove. A test-bar adapted to swing on one of the index plugs was equipped with a delicate test indicator at the opposite end. This indicator was used for adjusting the plugs until each plug was located at exactly the same distance from adjacent plugs. Similar tests were made to prove that the distance of each plug from the center of the fixture was exactly the same. The method of indexing is rudimentary in its simplicity, but it possesses the valuable feature of eliminating lost motion entirely. The index plug is strapped down on a hardened and ground steel plate which is carried on the top of a cast-iron block fastened to the surface plate. The operation of the fixture and the resulting accuracy of the work produced on it left noth-

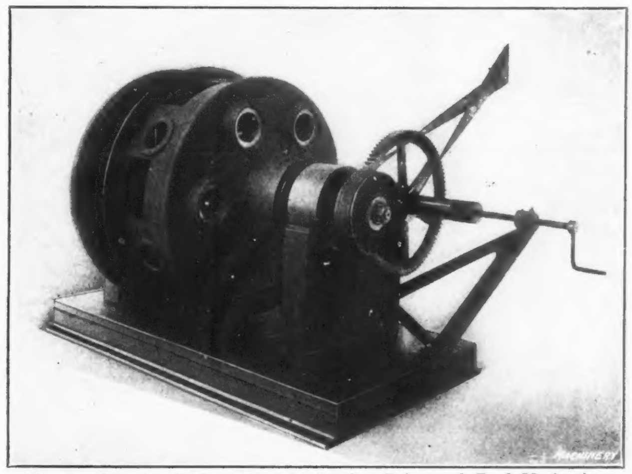

Fig. 2. Opposite End of Fixture showing Drive and Feed Mechanism

ing to be desired. The total time required for boring the piece was sixteen hours, and as this was the first piece to be machined in this fixture, it is felt that subsequent pieces can be machined in a much shorter time. Five of the bearings were located in exactly the required position, while the sixth one was 0.0005 inch out of the way.

Fig. 3. Final Test of Location of Index Plugs with Dial Test Indicator

The question has been asked why some simple form of power feed was not used instead of relying upon the rather crude hand feed. It was felt that a workman who was competent to do this work satisfactorily could produce the desired results with the hand feeding device shown in the illustrations, and experience has shown that this assumption was correct. The accuracy and rapidity with which the work was done entirely fulfilled expectations. The fixture was designed and built by the writer, with the assistance of Mr. C. F. Larzelere, superintendent of Giddings & Lewis Mfg. Co., Fond du Lac, Wis.

*Address: Madison, Wis.

Planing Turret and Slide of Semi-automatic Turret Lathe

Figs. 3 to 8 show the methods used in machining a turret and turret slide for a semi-automatic turret lathe which is being built for the writer by the Phoenix Mfg. Co., Eau Claire, Wis.

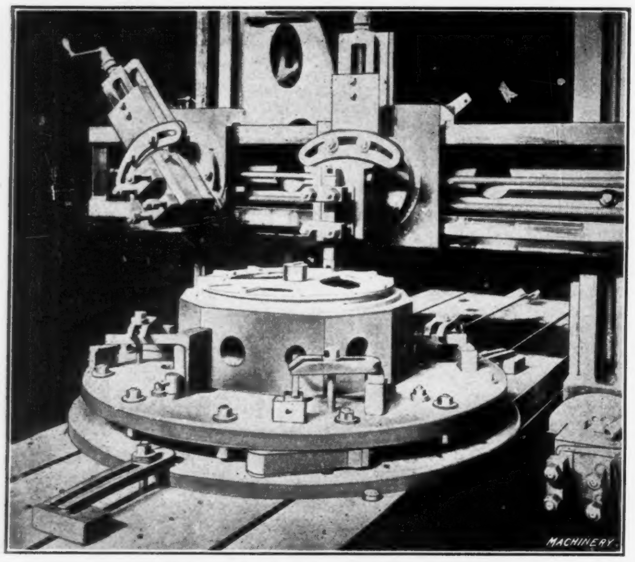

Fig. 4. Planing Teeth of Turret of Semi-automatic Lathe

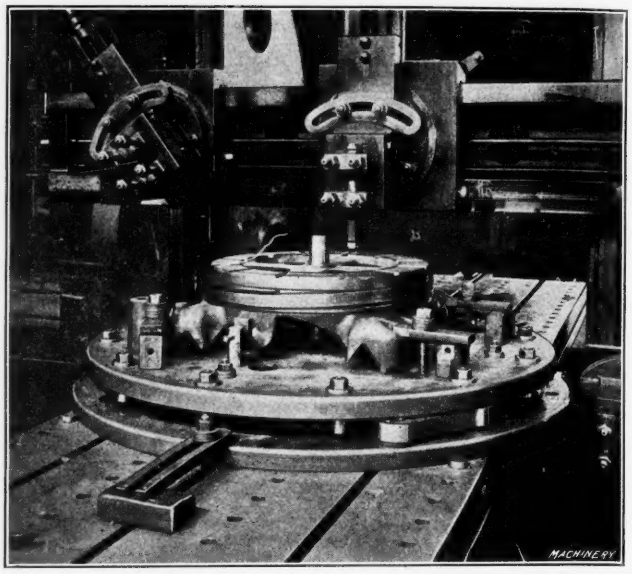

Fig. 5. Planing Spaces in Turret Slide to receive Turret Teeth

The turret of this semi-automatic turret lathe is provided with twelve holes and after it has been indexed to bring the required tool into the operating position, it is locked to the turret slide by means of the twelve teeth and spaces shown in the illustrations. The fixture shown in Fig. 6 was designed for indexing the work in order to plane these teeth and spaces. These operations are unusual, in that it is necessary to finish the work within very close limits in order to have the teeth on the turret engage properly with the spaces on the turret slide.

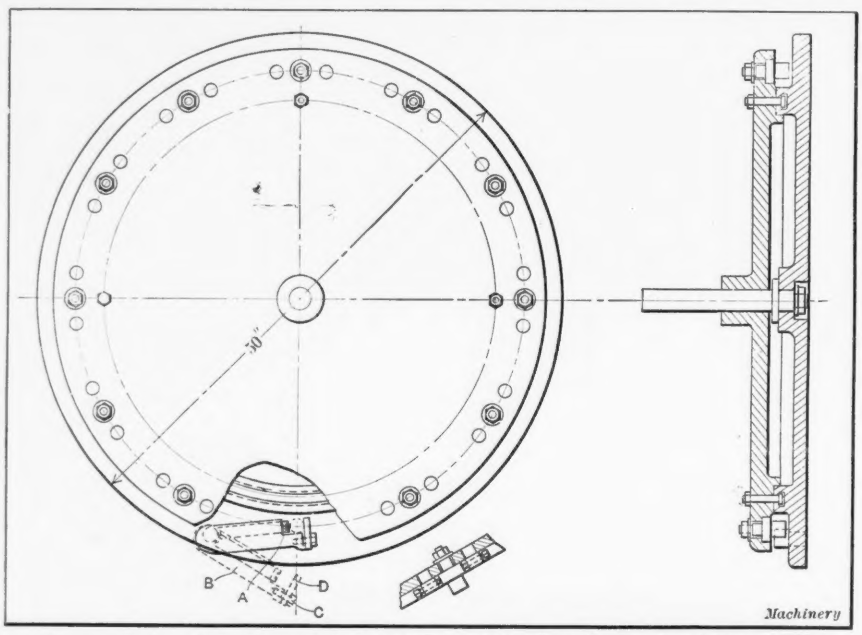

Fig. 6. Design of the Planer Indexing Fixture used to plane the Turret and Turret Slide

It will be seen that the fixture consists of two plates, the lower plate being bolted to the planer table, while the upper plate is carried on an arbor upon which it can be rotated in relation to the lower plate. The upper plate has twelve plugs mounted on its lower side. These plugs are made of steel and were ground and lapped after hardening to insure having them of exactly the same size; they were then carefully spaced around the diameter of the plate by means of a vernier caliper, the final adjustment being made with a dial test indicator as shown in Fig. 3.

In using this fixture to index for the twelve teeth on the turret or spaces on the turret slide, successive plugs on the index plate are brought up against the hardened steel plug *A* of the lock mechanism *B*. The bolt *C* is then tightened to clamp the plug *D* over the index plug. In this way the fixture is held securely in position and the planing operation can then be carried on. Fig. 4 shows the teeth being planed in the turret and Fig. 5 shows the operation of

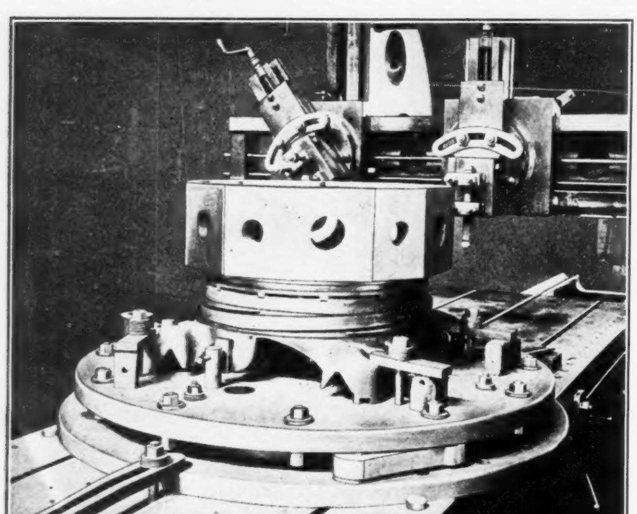

Fig. 7. Testing Accuracy of Teeth and Spaces of Turret and Slide

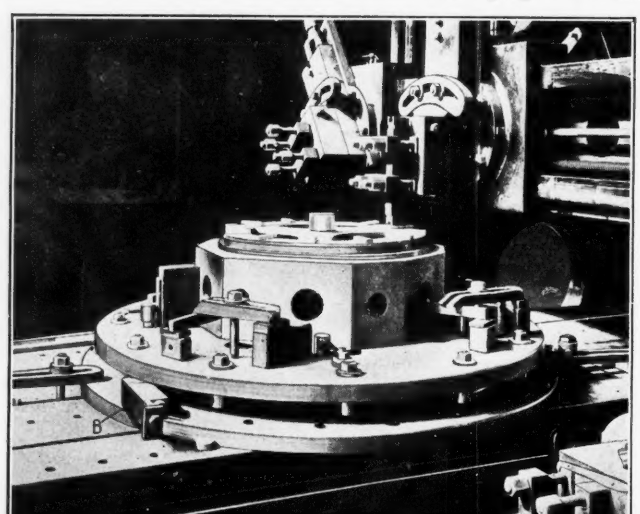

Fig. 8. Planer Indexing Fixture with the Lock Mechanism B swung back

planing the spaces in the turret slide. After these operations were completed, the table of the planer was run out sufficiently to allow the turret to be placed in position on the turret slide as shown in Fig. 7, in order to test the accuracy of the teeth and spaces.

This index plate was made in the shops of the Phoenix Mfg. Co., Eau Claire, Wis., under the direction of Mr. Neys, superintendent of the company. The operation of planing the turret and turret slide was also conducted in these shops and as previously stated, the work was finished within very close limits.

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A CASE OF DEFLATION

BY GEORGE WILSON*

It is an idiosyncrasy of human nature to derive considerable satisfaction from the discomfiture of a performer who is putting on frills in an effort to aggrandize himself in the eyes of the audience—in plain English, "playing to the grandstand."

Bill and I were making the rounds of the machinery section of a state fair. A crowd that was gathered around the exhibit of a carriage-maker drew our attention, and on edging our way to the front we found the attraction to be several blacksmiths at their forges producing the various iron parts that went into that particular make of buggy. The *piece de resistance* of the exhibit proved to be a young fellow of perhaps twenty-five years of age, and it was quite evident that if there was any applause lying around loose he meant to have it.

He was a typical melodramatic smith, tall, broad-shouldered and a "good looker" generally. His hair was carefully arranged; his blue flannel shirt was open at the throat, disclosing a section of manly chest, and his sleeves were rolled rather higher than was necessary to give play to biceps that knotted and swelled just a little more than the job warranted. His get-up was one of "studied indifference" as the novelists say. But his action! Chesterfield and the Apollo rolled into one had nothing on him. Grace incarnate. The poetry of motion. The methodical plodding of the veterans at the other anvils was only cheap newspaper prose compared to his easy grace.

"My, ain't he grand!" breathed a callow damsel ecstatically through a mouthful of popcorn.

His pride was partly excusable, for he was really a good workman. With a few deft blows he would have a rod welded and bent into a graceful scroll. Then to prove the merit of the weld and the quality of the material he would bend and twist the cold piece over the anvil.

One of the duties of the smiths was to pass out souvenirs in the form of pewter facsimiles of a medal the carriage concern had won at some exhibition. This the Apollo did with a fine condescension.

"That guy is all right, but he ought to take something for his head," muttered Bill. Then to the Apollo, timidly, "Don't you ever get a bum weld?"

If a look could have killed, Bill's demise would have been swift and terrible. Chastened and contrite, Bill slunk back as Apollo flourished his irons from the fire and struck the uniting blow. Amazed he looked at the glowing ends. They had not stuck! Back to the fire. Another trial. Nothing doing. Some of the crowd tittered. The veterans at the other anvils grinned appreciatively and the Apollo's face got red. There were no flourishes when he grabbed some new irons and brought them to a heat. Biff! Bang! Swat! The pieces stuck about as nicely as a couple of pieces of brass would have done.

Apollo ceased his effort and mopped his classic brow. The hauteur had all oozed out. The snickers became general and included a few uncomplimentary remarks.

"Let's get out of here," muttered Bill. As we turned to leave the Apollo started to heave out his fire. Outside the crowd, Bill exploded and a suspicion dawned in my mind.

"Bill," I demanded, "what did you do to that fellow's fire?"

"Nothing much," grinned Bill, "just dropped a couple of his medals into it."

* Address: Madelia, Minn.

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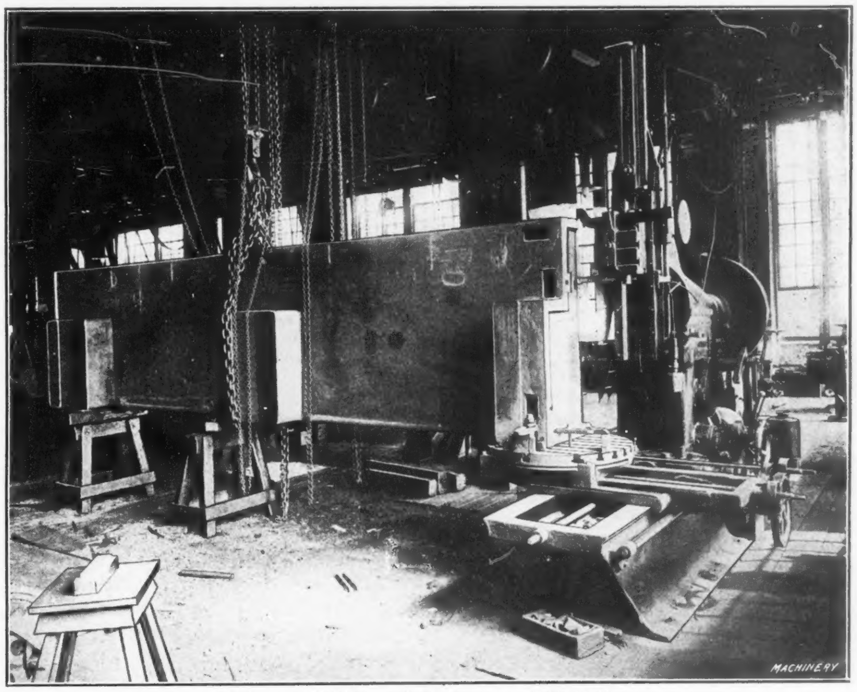
A LARGE SLOTTER JOB

In building a large special drilling machine at Edwin Harrington Son & Co.'s shops, at Philadelphia, Pa., the bed was constructed in quarter sections, and to join these sections properly it was necessary to machine the sides and ends. The sides were readily finished by planing, but the machining of the ends presented unusual difficulties because of the great size and weight of the work.

The halftone shows how the parts were machined on a Dill slotter. The casting was supported from a ten-ton crane and located with one end resting on the slotter table. As the length of the cut measured 51 inches and the full stroke of the slotter was only 20 inches, it is evident that the surface had to be finished in three cuts. In order to get up high enough to start the first cut a special offset slotting tool was forged, and this was clamped at the extreme top of the tool-holder. This tool being properly set, the casting was machined as far as the offset portion which is shown in the illustration. Of course the feeding across the work, which was a distance of twelve inches, was accomplished by using the traveling head, which is a distinguishing feature of the Dill slotter. After this section had been surfaced, a straight slotting tool was mounted in the tool-post and a second cut taken, leaving the stroke of the ram still at its highest position. The stroke was next transferred to the lower section of the work and the remaining part of the work thus completed. C. L. L.



Facing an 11,500-pound Casting on a Dill Slotter

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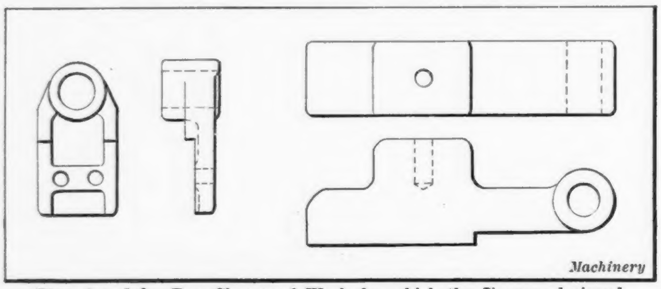
Reaming is commonly regarded as an internal cutting operation—that is, as enlarging a hole. But reaming is both internal and external. Box-tools are examples of external reamers. These usually ream or turn straight or cylindrical parts but they are also successfully used for taper work up to lengths of eighteen inches and diameters of $1\frac{1}{2}$ inch or more. A prominent example is the locomotive taper turning tools used on special vertical machines in locomotive building and repair shops. The speed with which taper bolts are turned or reamed to exact sizes would astonish one not familiar with this work.

A UNIVERSAL DRILL JIG

A DESIGN PRIMARILY INTENDED TO HANDLE CASTINGS HAVING A ROUND BOSS ON ONE SIDE

BY CHRISTIAN F. MEYER*

The universal drill jig described and illustrated in the following was designed for drilling parts which are quite different in shape but which all have a round boss on one side.



Figs. 1 and 2. Two Classes of Work for which the Jig was designed

Figs. 1 and 2 show two typical examples of the class of work for which this jig was designed, and with slight modifications which will be explained later, the jig could be adapted for both drilling and boring operations on a great variety of work.

Referring to Figs. 3 to 6, it will be seen that the jig consists of a cast-iron baseplate *A*, which is provided with a dovetail slot in which three slides *D*, *G* and *K* are held, so that they may be moved longitudinally by screws and operating keys. A cast-iron guide piece *V* is also held in the dovetail slot in the base of the jig, and this guide carries the lower bushing *W*. This construction will be readily understood by referring to Figs. 4 and 5.

The slide *D* is provided with two bolts which slide with their heads in a suitable slot in the base *A*, and handle *E* is fastened to this slide, the hub of the handle being cam-shaped, as shown in Fig. 3. The cam forces the slide *G* forward when handle *E* is turned in the proper direction. Slide *G* is loose in the slot in casting *A*, and is connected to the slide *D* by means of two studs *I*. Each stud is provided with a spring *J* which draws slide *G* toward slide *D*. The top of slide *G* is cut away to receive the guide pieces *H*, a different form of guide piece being required for each class of work which is drilled in the jig. In order to explain the operation of this jig, it has been assumed that it was designed for drilling six classes of work, known as Patterns I to VI. Pattern No. VI is shown in detail in Fig. 2, and the same piece is shown mounted in the jig shown in the illustrations. It will be seen that the guide piece *H* for this particular piece is designed in such a way that the work is held by means of two screws with knurled heads. The guide piece is held on slide *G* by means of a washer and nut, which fit a stud in the slide. Slide *K* is also cut away for the V-block *L*, which receives the end of the piece to be drilled.

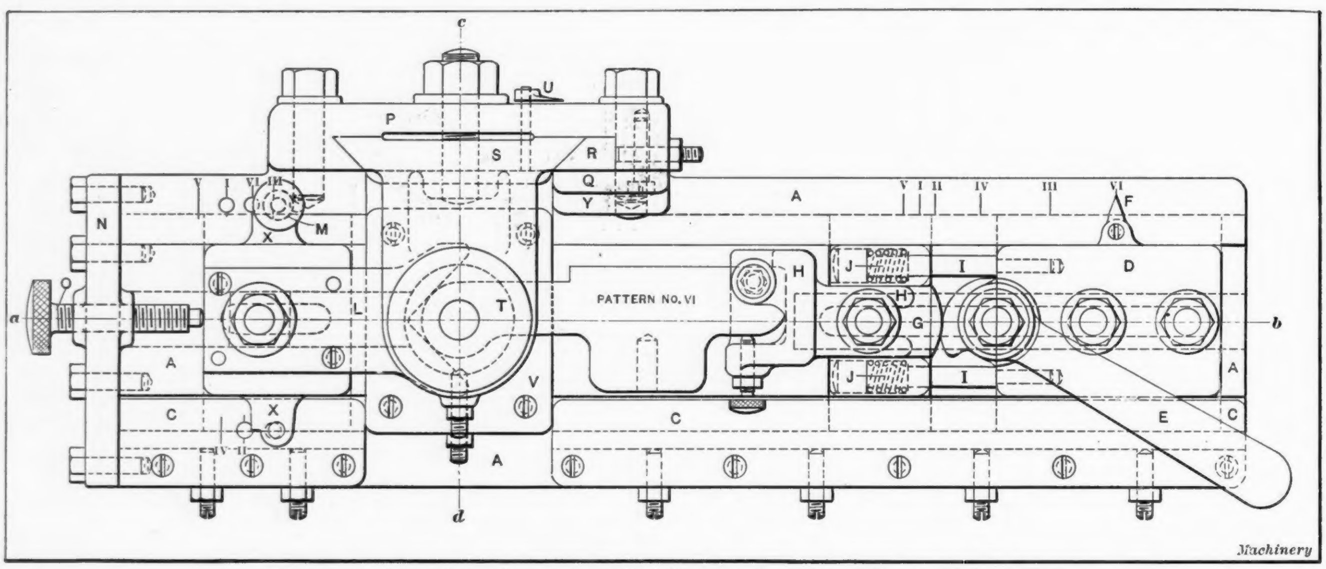


Fig. 3. Plan View of the Jig, showing Adjustable Slides for holding Different Kinds of Work

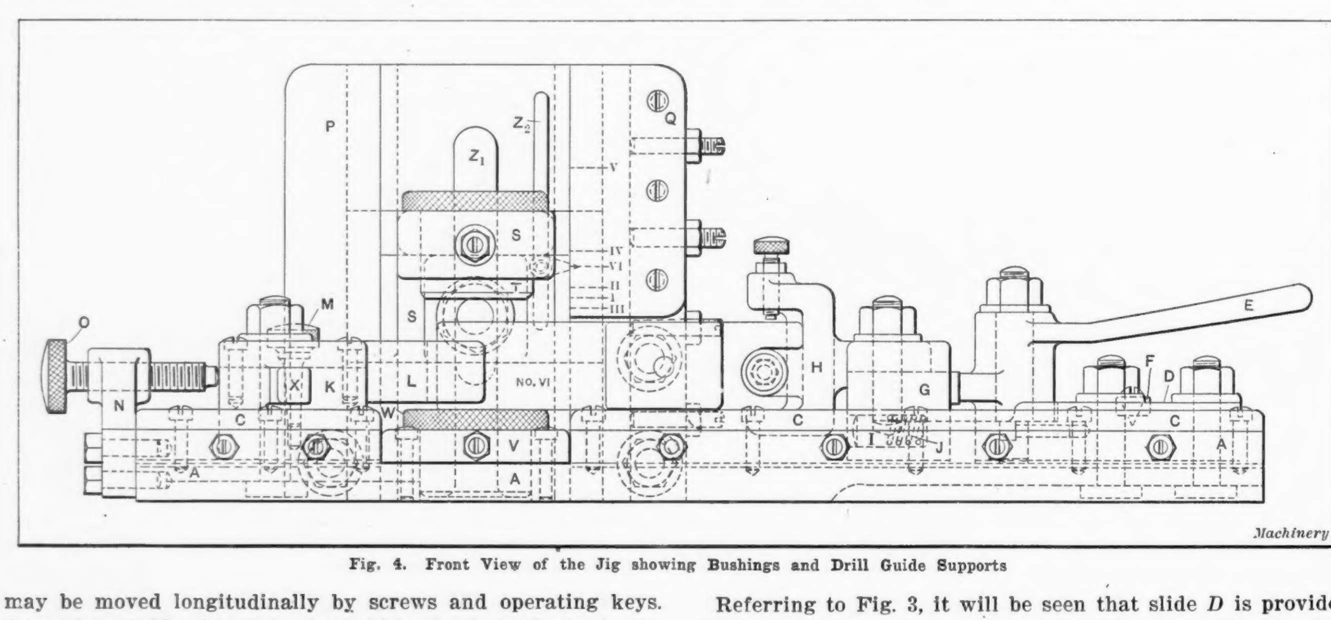


Fig. 4. Front View of the Jig showing Bushings and Drill Guide Supports

Referring to Fig. 3, it will be seen that slide *D* is provided with a pointer *F*. In adjusting the jig for any particular class of work, the bolts which hold the slide are loosened; the slide is then moved along the slot in the casting to bring the pointer

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F to the graduation which indicates the class of work which is to be machined. The bolts are then tightened to secure the slide in this position. As shown, at the other end of the jig there are similar graduations which provide for setting slide *K* and V-block *L* in the required position, the method of adjustment being similar to that described for slide *D*. It will be seen that an adjusting screw *O*, carried by the piece *N*, provides for adjusting the position of slide *K*. This slide has a pointer *X*, which is brought up to the graduation that indicates the class of work to be drilled. A taper pin *M*, fitting into corresponding holes in the top of base *A* and cover *C*, serves to locate slide *K* and V-block *L* in exactly the required position, thus insuring an accurate location of the work.

The guide *V* is fastened to base *A* and receives a hardened steel bushing *W* which is held in place by a pointed set-screw. In a similar manner, the bushing *T* is held in the arm of the slide *S*. Both bushings are provided with a knurled flange and may be easily removed to be replaced by different bushings for another kind of work. The outside diameter of all of the bushings is made alike, however, so that they all fit the same holes.

The slide *S* is carried in a dovetail slot in the support *P*. The cover *Q* and key *R* are used to adjust the position of slide *S*. The support *P* is fastened to an extension on base *A* by means of bolts, the construction being clearly shown in Figs. 3 and 6. Slide *S* is held in the support *P* by a strong stud, washer and nut, and may be fastened in any desired position, the stud moving in the slot Z_1. A narrow slot Z_2 guides a smaller stud which has a pointer *U* fastened to it. This pointer slides over a scale graduated on the back of the support *P*, which indicates the correct position of slide *S* for different classes of work which are being drilled in the jig.

After the three slides *D*, *K* and *S* have been set, the jig is ready for use. The quick-acting cam lever *E*, in connection with the automatic releasing slide *G* and guide piece *H*, works very efficiently, and the guide pieces *H* and *L* locate the work with great accuracy. Although this jig was only constructed for work with a round boss—as shown in Figs. 1 and 2—it will be readily seen that it could be adapted for almost any shape of work by replacing the V-block *L* by a member somewhat similar to the guide piece *H* on the slide *G*. This jig might also be arranged upon the faceplate of a lathe or boring mill. The drill guide would then be unnecessary and the bushing *W* would be made in such a way that the pilot of the cutter would enter the bushing before the cutting operation began. This would provide for an accurate cut.

The operation of the jig is so simple that any boy can handle it. In addition, the jig is "fool-proof," as the special guide piece and setting of the slides will not suit any class of work except the one for which it is designed. The use of a universal jig of this kind saves the expense of making individual jigs for each class of work and also means a considerable saving of space in the tool-room.

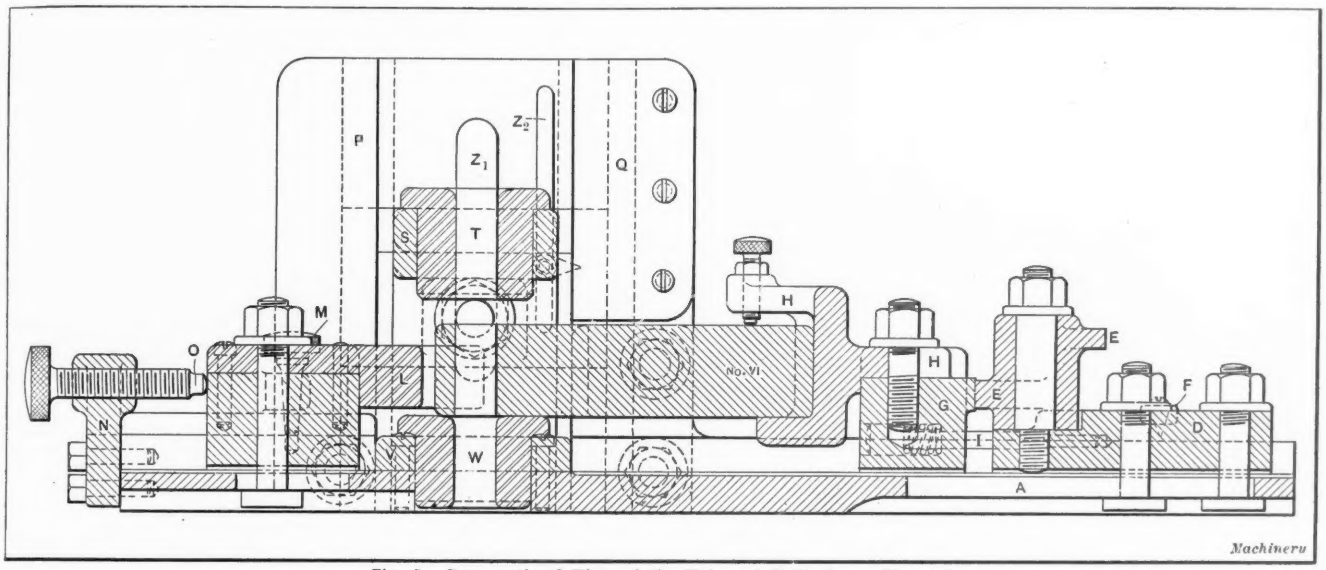

Fig. 5. Cross-sectional View of the Universal Drill Jig on Line a–b

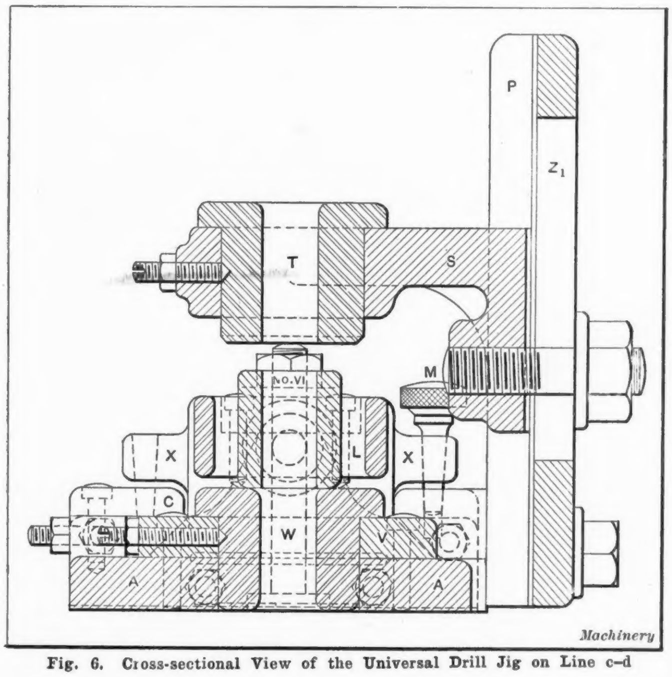

Fig. 6. Cross-sectional View of the Universal Drill Jig on Line c–d

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USELESS LABOR IS THE ONLY UNPRODUCTIVE LABOR

"If a lot of capital is***spent in unproductive ways, there will be not only less for other uses, but the natural growth of capital will be arrested in proportion as the uses to which it is devoted are unproductive. When you put $10,000,000 of capital into an industry or a railroad it multiplies itself; when you put capital into armament, meaning warship and standing armies, as has been done on so vast a scale in Europe, or when you spend it on monuments which in themselves have no earning power, as has been done widely in this country, the capital is, in the economic sense, lost. It cannot multiply. The enormous expenditure of capital all over the world in unproductive ways is the fundamental explanation of the present scarcity of capital."—*New York Evening Sun.*

[The statement above would have been equally, or, perhaps, even more directly applicable and true if the writer had referred to labor spent in unproductive ways. In the last analysis, capital spent in unproductive ways is really labor thus spent, and the enormous expenditure of labor all over the world in unproductive ways is without question a fundamental reason for many of our financial, economic and social difficulties.—EDITOR.]

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A reliable aluminum solder, used by a large electrical concern, is composed of 75.5 parts, by weight, tin; 18 parts zinc; and 2.5 parts aluminum. No flux is needed.

PHOTOGRAPHIC DEPARTMENT OF THE NATIONAL-ACME MFG. CO.*

THE EQUIPMENT AND FUNCTIONS OF AN INDISPENSABLE FACTOR IN MODERN ADVERTISING AND SELLING

BY F. SLUKA, JR †

The National-Acme Mfg. Co., of Cleveland, Ohio, in common with many other manufacturing companies, had a great deal of difficulty in getting suitable photographs from outside photographers, due to their lack of special training in photographing mechanical subjects, and to the fact that they were forced to work under difficulties, such as lack of a suitable place to take the pictures and conveniences for preparing the subjects to be photographed. The company therefore established its own photographic department, as a branch of the advertising department, during the month of August, 1910, as an experiment toward getting better photographs at less cost. In three years' time the photographic department has made itself practically self-sustaining, and it is doing so much better work in its line than the company was able to get previously that it has come to be regarded as a valuable adjunct to the advertising and sales divisions of the business.

Fig. 1. Section of National-Acme Mfg. Co.'s Photographic Department

The extent of the work carried on by the photographic department can be judged from the fact that during the past year the builders of the Acme automatic multiple-spindle screw machine used about 850 photographs per month for advertising and sales purposes, which means the use of over 10,000 photographic prints during the year. If outside photographers had been employed as required to get these pictures, a member of the sales or advertising force would have had to be with the photographer on each occasion, to see that he got the view of the machine desired, that the subject was prepared properly, and that the proper parts of the mechanism were brought out according to the requirements. An outside photographer, lacking familiarity with machinery in general and with the Acme automatic in particular, could not be expected to get this without supervision. With his own department, however, the advertising manager tells the head of the photography branch just what he wants, and then forgets about it until the photographic department shows him the finished prints that he ordered. The sales department puts in an emergency call at any time for any special photograph and the photographic department has it ready in a day or so without further attention from the sales department. This is a very great convenience to the heads of the sales and advertising departments, and it soon saves a lot of time and expense to the company. The National-Acme Mfg. Co. uses photographs in the following ways:

1. *For Records.*—The advertising department has all sorts of views of machines, parts, and tools taken at different times for many purposes. Every time a new photograph is made for any purpose whatever, the necessary working prints, for retouching, mailing, or other use, are made from the negative and at the same time one record print. The negative is then filed away in the racks provided for that purpose, the working prints are used or sent out as required, and the record print goes into one of the record binders, according to its classification. The record photographs are separated into twelve different classifications and each is kept in substantial binders and properly labeled for reference at any time. These record photographs are also listed in a card index, and the number on the negative also appears on the record print and on the

* For articles on shop photography previously published in MACHINERY see: "Shop Photography," January, 1910, and the other articles there referred to.

† Address: National-Acme Mfg. Co., Cleveland, Ohio.

proper card in the card index. Needless to say, this library of record photographs is extremely useful and valuable. It is in many ways, a history of different experiments and developments in building the Acme automatic multiple-spindle screw machine during the period that the photographic department has been in existence.

2. *Photographs for answering Inquiries and for Sales Promotion Work.*—When inquiries about the machines, their

Fig. 2. Photographing Machine in Perspective for Line Drawing Copy

work, their parts or their product are received, a very clear answer can be given the inquirer by sending him a photograph and a brief letter of explanation. The sales promotion department finds these photographs very effective as auxiliaries to the promotion letters. The photographs establish a

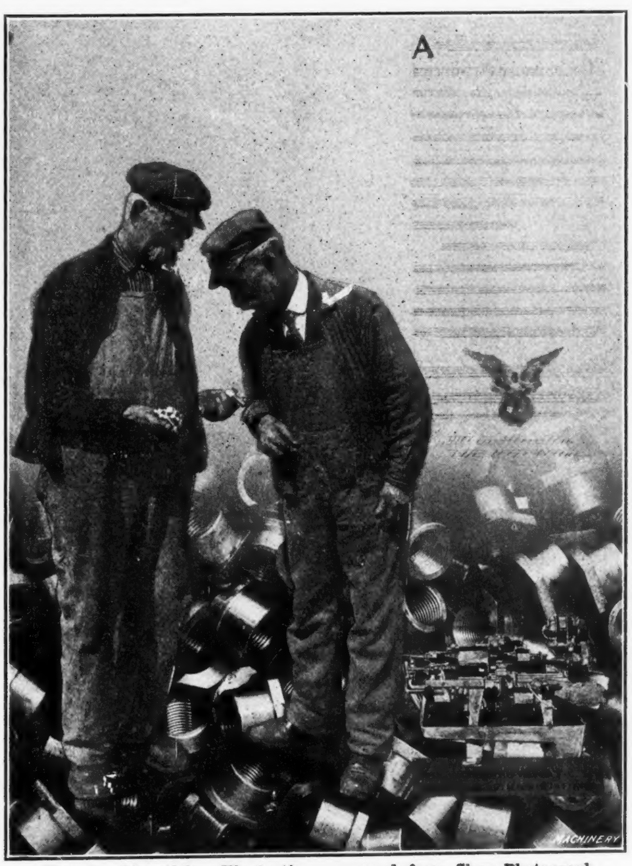


Fig. 3. Advertising Illustration composed from Shop Photograph

bond of interest with the prospect and illustrate the truth of the points brought out in the letters. One of the big advantages of a photographic department for the business comes in right here. The men in the photographic department, through familiarity with the machines and their uses, develop the sense of mechanical values which is so necessary in order to get the real sales force into the photographs. By specializing, so to speak, on the Acme machines, they know how to bring out certain parts of the machines or features of their use, according to the requirements, and thus get pictures that have real educational and sales value, as well as artistic beauty. Some of these pictures are printed on black backgrounds with soft gray tones for the masses and high lights for the details of the machines. This treatment, besides being distinctively original, subdues the non-essentials and brings out the essential parts of the machines. Other pictures of machines have the background left in purposely, while on others it is painted out on the negative.

3. *Photographs for Retouching.*—Retouching photographs is at best an expensive process because it means hand painting by high-priced craftsmen. The cost of retouching can be minimized by the use of fine photographs, or magnified by the use of poor ones. It is a question of the amount of the artist's time required to fit the photograph for engraving. As a photograph of a simple object will cost only about $1.50 to $2.50, while the retouching necessary may cost anywhere from $5 to $50, according to the photograph, it seems wise to take more time for the photographing and save

Fig. 4. The "Skyscraper" Camera photographing a Group of Screws

the more expensive time of retouching. The National-Acme idea is to spend a little more time and money on the photographs and save a lot on the retouching. The photographic department, in getting photographs which are later to be made into engravings, is very careful to get the clearest possible pictures to bring out the salient parts of the machine, which should be strong in the printing.

4. *Photographs for Line Drawing, or for Poses of Individuals for Advertising Purposes.*—Fig. 2 shows that when line drawings of machine parts are wanted, it is quite a simple matter to go into the shop and make a quick photograph from the proper angle, from which it is easy to make a pen-and-ink drawing. Such photographs do not need to have the light and shade contrast that the better photographs must have, but they should show as much detail as will be required in getting material for the artists to work on, so as not to waste the artists' time. A camera is often taken into the shop to get a quick photograph of a man or group of men in some characteristic pose to illustrate an idea for an advertisement. (See Fig. 3.) Sometimes line drawings for engravings are made from these pictures, and sometimes the photographs are used as copy for halftones with a background of machines or some other effect sketched in.

5. *Photographs to be enlarged for Advertisements or for Framing.*—Magazine pages are in some cases larger than 8 by 10 inches—the usual size of the photograph—and in making the engravings for printing, as it is always advisable to reduce from the photograph, they are frequently thrown up to a much larger size, retouched if necessary, or perhaps lettered, and then sent to the engraver, who photographs them in reduced size to the proper size for the plate. This gives more detail in the finished cut. Enlargements of the Acme automatic machine and views of the factory are also made for framing. These pictures are sent to the branch offices and to other companies interested in having them on their office walls. These pictures are often made with the black background treatment referred to above.

The National-Acme photographic department has a well-equipped studio for taking pictures, a section of which is shown in Fig. 1. It is located on the top floor of one of the three bridges which connect two wings of the plant—an ideal place for photographic work, as an abundance of light is available from both sides and above, and the vibration common to large manufacturing plants is not felt in the suspended bridge. The studio is equipped with two 8 by 10 Century cameras, one for copying work and enlarging, and the other for general photographing; one 11 by 14 Century camera which is chiefly used for catalogue work; and a 5 by 7 Graflex which is used on special work. Four lenses are in use, *viz.*, one 19-inch, one 12-inch, one 8-inch Dagor, and one Bausch & Lomb Zeiss-Protor, Series V for extremely wide angle work.

When one of the Acme automatics is to be photographed it is brought into the studio from the elevator on a portable crane, and placed on a turntable by means of which the photographer can turn the machine easily to get any view desired. This is shown in Fig. 5. The turntable allows him to take advantage of the best lighting available at the time, and this is a particularly important feature in obtaining the best results. Artificial light is often used in photographing sections of the machines where the daylight fails to penetrate, and for this purpose a Cooper-Hewitt light is used as an auxiliary to the daylight in the studio.

Before photographing the machine, it is usually prepared by painting to avoid excessive retouching and to get a smooth effect in the engraving. The paint used by most photographers is made of lampblack and gasoline. The objection to this is that it is very quick-drying and requires care to apply it without getting a streaky effect. The lampblack must then be scraped off before finish-painting the machine for shipment. The National-Acme Mfg. Co. prepares the machines by wiping off all oil and grease, and then applying an oil paint that is a flat but not a dead black. (See Fig. 6.) This paint dries smoothly and with just enough luster to give the image a little snap. A picture of the machine prepared for photographing in this way will reproduce much better than one treated with the lampblack coating. The oil paint will not rub off, and a finishing coat of gloss paint, applied after photographing, makes the machine ready for shipment.

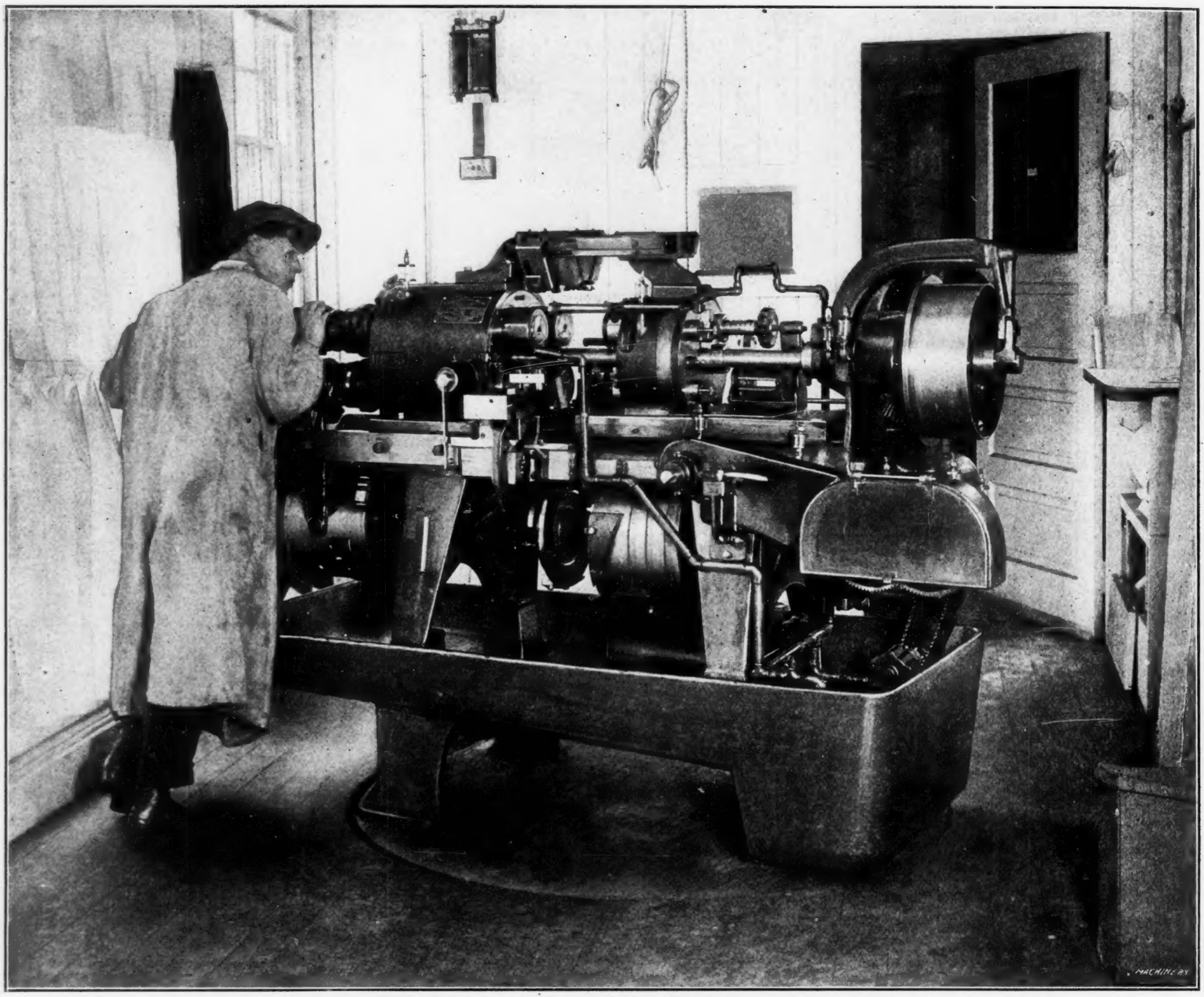


Fig. 5. Acme Screw Machine being posed on Turntable for photographing

A large part of the work of the photograph department consists of making pictures of screws and small parts which are the product of the machines. It has been found desirable to photograph these groups of parts in a horizontal position to avoid the trouble of nailing or wiring them to a board. Such photographs are taken with what is called the "skyscraper" camera, which is shown in Fig. 4, and this method is particularly advantageous when the parts are being photographed for reproduction, as no time is lost in working out the nails or wires from the print. The skyscraper camera, as arranged to take objects at an angle or straight down, is bolted to the top of the stand, and as one end is hinged it is

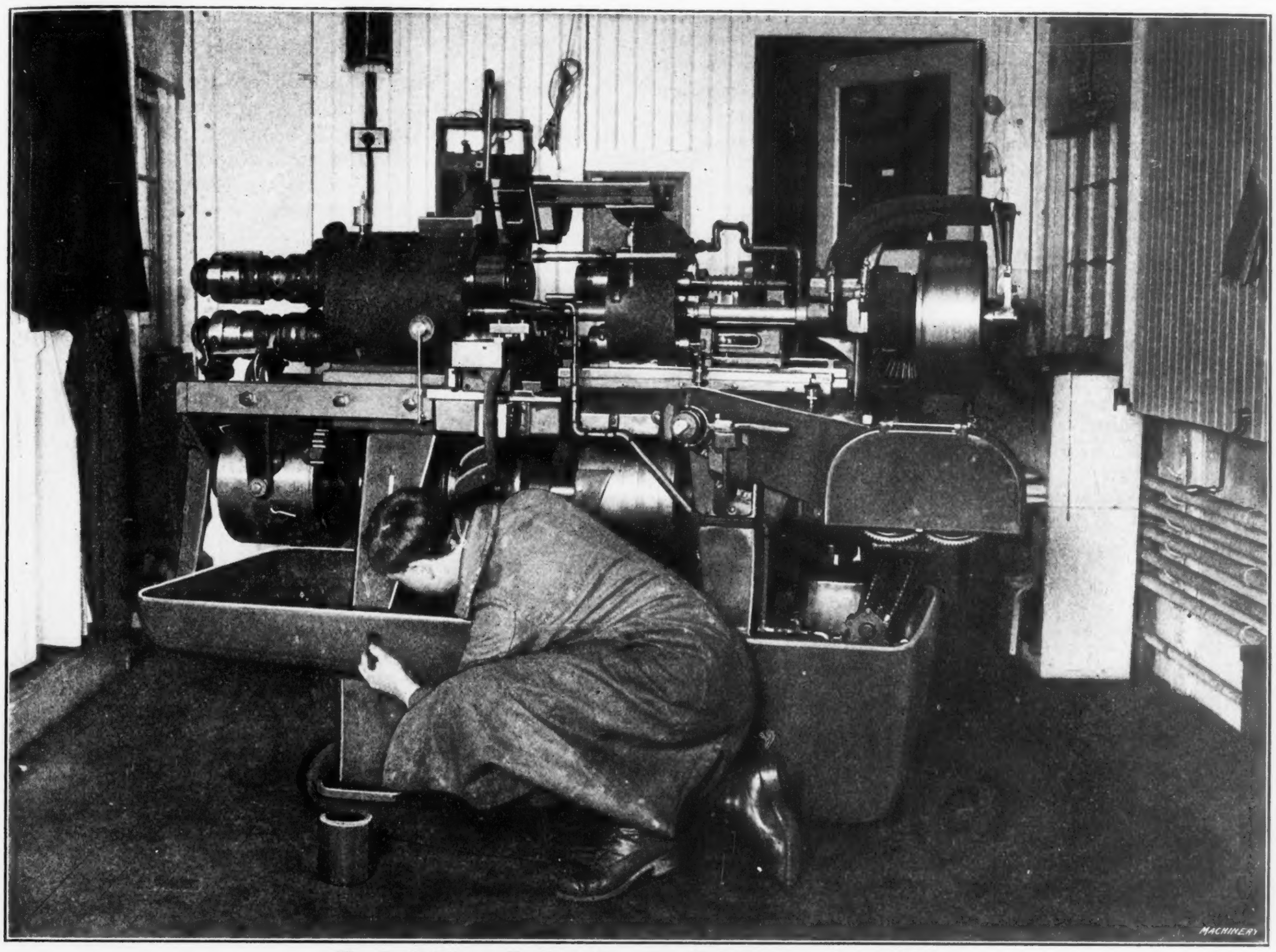


Fig. 6. Painting a Machine with a Flat Oil Paint before photographing

Fig. 7. Equipment for making Photographic Enlargement

possible to tilt the camera to any desired angle. The top is held in position by means of braces which are clearly shown in Fig. 4. In photographing screws or small parts when it is desirable to have the pieces cast a shadow for a natural effect, the group is laid on a sheet of clean white paper and the lighting arranged to strike the group at an angle of 45 degrees. When a pure white surface is desired, to show that the pieces are accurate, a piece of glass is used upon which the pieces are placed as is shown in Fig. 4. The objection that photographers have to using glass for this purpose is that it is impossible to hold the pieces in the position desired. This can be overcome by the use of small pieces of putty, which are placed under the parts to hold them firmly in position. This putty is prepared by heating beeswax and mixing it with vaseline, two parts of wax being mixed with one part of vaseline.

The National-Acme Mfg. Co. uses quite a good many enlargements. These are made in a dark room by means of a Cooper-Hewitt light and the regular 8 by 10 Century camera. One of the walls in the dark room has an opening about twenty inches square, through which the light enters. (See Fig. 7.) Over this opening, inside the dark room, a frame is built in which the plate to be enlarged is held. The Century camera, with the ground glass carrier detached, is fastened to this frame in front of the plate. Then the Cooper-Hewitt light is placed outside and close to the opening in the dark room wall and the light is thrown through the plate and lens onto a board. This board is fastened to a sliding frame suspended from the track in the ceiling. The overhead track runs the full length of the room, and the board can be adjusted toward or from the camera, according to the degree of enlargement required. (Fig. 7 shows this arrangement clearly.) Of course, the farther the board is from the camera the larger the image.

For developing plates, different kinds of developers are used to get different effects—usually metol-pyro for soft effects and hydroquinone for contrasting effects. The standard formulas published by plate and paper makers are used in this department because they have been found to give the best results claimed from the use of the different plates and papers. For most purposes metol-pyro is found to be a very good universal developer, as it produces soft effects and good transparent blacks. Wooden trays, about three feet by four feet, lined with oilcloth, are used for developing the enlargements. Separate rooms are provided in the advertising department for developing and printing from the negatives taken in the studio in the factory bridge. An unusually complete filing system is intact for both negatives and record prints for reference.

* * *

What is to be done with the fresh-air crank in the drafting-room and the equally absurd creature who is afraid of death if a whiff of fresh air touches him? Many disagreeable scenes are enacted in offices and other quarters where men and women work. Some are constitutionally unable to work unless the air is cool and fresh while others thrive best, in their own opinions at least, with all windows closed in winter and the temperature at 75 degrees F. The remedy is to provide in modern structures a heating and ventilating system that insures an equable temperature and air condition in all parts of an office or work room without requiring local ventilation by windows, doors or registers. Then control is removed from individuals who must perforce be contented with the conditions, or get out.

* * *

Up to the present some $7,000,000 has been earned by the United States Patent Office by fees, and turned into the treasury of the United States. The present fees provide more than enough income to pay for the cost of examining patent cases. Nevertheless, a bill has been introduced into Congress proposing an increase in the fees for patent applications from $15 to $20. We see no good reason for this increase as long as the letters patent remains merely a license to sue for infringement. The aspect would be different, of course, if the government undertook to protect an inventor directly in his patent rights after a patent had once been granted to him.

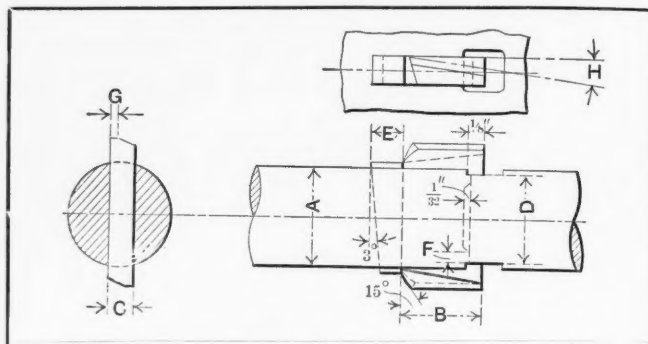
FLAT CUTTERS FOR BORING HEADS

BY FRANK H. MAYOH*

Although boring bars with inserted double-edge flat cutters are in general use, few attempts have been made to standardize the dimensions, shapes and angles. The accompanying table gives the dimensions of flat cutters for boring bars that have given satisfaction in use. While the range of 3/8 inch to 2½ inches diameter of bar is perhaps wider in the direction of the smaller sizes than will be generally required, the extent of the table will be helpful in plotting larger sizes than 2⅛ inches, if required.

The cutter is of the dependable type, fixed in a slot and secured by a wedge, and has ledges that overhang the sides of the bar at one end of the slot. The ledges locate the cutter centrally and prevent change of position. If cutters for bars of intermediate diameters are wanted, use the cutter dimensions of the bar for the next larger diameter. For example, the dimensions of the cutter and parts required for a bar 1 15/16 inch diameter should be made the same as the dimensions given for a 2-inch bar.

FLAT CUTTERS FOR BORING BARS



A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
3/8	7/16	3/32	11/32	1/8	1/16	1/32	5°	2¼	1½	7/16	2 3/16	5/16	1/4	1/16	8°
1/2	5/8	1/8	15/32	1/8	1/16	1/32	5°	2⅜	1½	1/2	2 5/16	5/16	1/4	1/16	10°
5/8	5/8	5/32	19/32	5/32	1/8	1/32	6°	2½	1½	1/2	2 7/16	5/16	5/16	3/32	10°
3/4	3/4	3/16	11/16	5/32	1/8	1/32	7°	2⅝	1½	1/2	2 9/16	5/16	5/16	3/32	10°
7/8	13/16	7/32	13/16	1/4	1/8	1/32	7°	2¾	1½	1/2	2 11/16	5/16	5/16	3/32	10°
1	7/8	1/4	15/16	1/4	5/32	1/32	8°	2⅞	1½	1/2	2 13/16	5/16	5/16	3/32	10°
1⅛	1	5/16	1 1/16	1/4	5/32	1/32	9°	3	1½	1/2	2 15/16	7/16	3/8	1/8	10°
1¼	1 3/16	5/16	1 3/16	1/4	5/32	3/64	7°	3⅛	1 11/16	5/8	3 1/32	7/16	3/8	1/8	10°
1⅜	1 3/16	5/16	1 5/16	1/4	5/32	3/64	7°	3¼	1 11/16	5/8	3 5/32	7/16	1/2	1/8	10°
1½	1¼	5/16	1 7/16	1/4	3/16	3/64	7°	3½	1 11/16	5/8	3 13/32	7/16	1/2	1/8	10°
1⅝	1¼	5/16	1 9/16	1/4	3/16	3/64	7°	3¾	1 11/16	5/8	3 21/32	7/16	1/2	1/8	10°
1¾	1⅜	3/8	1 11/16	5/16	3/16	3/64	7°	4	2	3/4	3 29/32	1/2	1/2	1/8	10°
1⅞	1½	3/8	1 13/16	5/16	3/16	3/64	7°	4½	2	3/4	4⅜	1/2	1/2	1/8	10°
2	1½	7/16	1 15/16	5/16	1/4	1/16	8°	5	2	3/4	4⅞	5/8	1/2	1/8	10°
2⅛	1½	7/16	2 1/16	5/16	1/4	1/16	8°	..	...	..	..	..	..	..	...

Machinery

Intermediate sizes made like nearest size above.

The table includes the desirable rake angles for the sides of the cutter, the angle of inclination of the cutter lips from the vertical, the width of land and other data on cutter characteristics not generally available. The cutting angles recommended apply to cast iron and mild steel.

* * *

PEAT POWDER AS A LOCOMOTIVE FUEL

Peat powder has been successfully applied as a locomotive fuel on one of the private railroads in Sweden. About 1½ ton of peat powder is equivalent in steam rising value to one ton of coal. Peat powder is used with a mixture of about 5 per cent of coal. The powder is fed into the furnace by an automatic stoker. No change need be made in the boiler and in the fire-box, except for the mounting and application of the automatic stoker. An incidental advantage of the use of the peat powder is that no cold air can get into the fire-box and no smoke or sparks escape from the smokestack. As Sweden is very rich in peat bogs and has practically no coal deposits the success of the apparatus, which has been worked upon for years by eminent engineers, is of considerable importance. It has been estimated that the cost of peat powder would be only about one-half that of coal.

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MACHINE FORGING—5*

DIES AND METHODS EMPLOYED IN THE FORMING, WELDING AND UPSETTING OF MACHINE AND ENGINE PARTS

BY DOUGLAS T. HAMILTON†

The production of the Ford front axle by forging machine methods is an excellent example of the general adaptability of the upsetting and forging machine to the manufacture of miscellaneous parts from carbon and alloy steels. When used in conjunction with a steam hammer or bulldozer, there is practically no limit to the range of work which can be successfully handled. One of the most recent developments in forging-machine methods which should be of unusual interest to many manufacturers is the application of forging machines to the welding of machine and engine parts. This in many cases permits the utilization of scrap metal, thus converting practically valueless material into expensive machine parts. Some interesting forging operations employed in the production of the Ford front axle and other parts, will be described in the following.

Forging the Ford Front Axle

In Fig. 59 is shown a series of interesting operations performed in the 3½-inch "National" forging machine shown in Fig. 60, the work being the front axle for the Ford automobile. In its preliminary stages of production this front axle is made from a vanadium steel bar 1⅜ inch in diameter by 67¾ inches long, as shown at *a* in Fig. 59. The first forging operation consists in forming the two bulges *a* and *b*. Both ends of the bar are formed in this manner, but in separate heats. This operation, which is also indicated at *B* in Fig. 61, shortens up the ends of the bar from a length of 16⅛ inches to 13½ inches, which means that 2⅝ inches of stock is put into the bulges. The forging machine dies for performing this operation are shown in Fig. 62, the bulging being accomplished in the top members. In order to form both bulges at once it is necessary to have the top members of these dies constructed in such a manner that the blocks carrying the impressions are free to slide forward when acted upon by the plunger held in the ram of the machine.

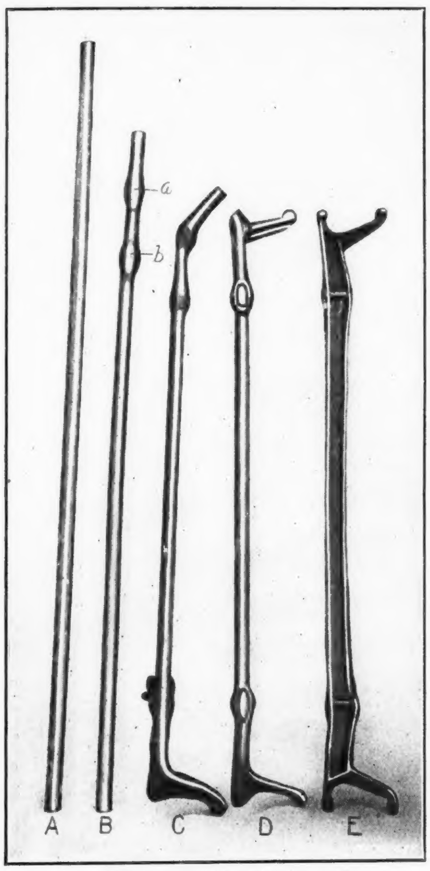

Fig. 59. Sequence of Forging Operations on the Ford Front Axle

As will be seen by referring to this illustration, one-half of the larger bulge is carried in the block *A*, while the other half of the impression is carried in the sliding block *B*. In the opposite end of the sliding block *B* is provided one-half the impression for the smaller bulge, the other half being formed in the sliding block *C*. These sliding blocks *B* and *C* are held by tongue plates *D* to the main body of the top forging die in which they are free to slide, being held in their outward positions by coil springs *E* and *F*. Coil spring *E* is carried on a stud held in sliding block *B*, while coil spring *F* is carried on a stud screwed into block *B* and fitting in a clearance hole in the sliding block *C*. The stock, when heated to the correct temperature, is located in the proper position

Fig. 60. "National" 3½-inch Forging Machine used in accomplishing the Preliminary Operations on the Ford Front Axle

in the dies by the block *G*, which is fastened by cap-screws to the block *C*, and covers the hole in the dies as indicated in the end view. The block *C* is located in its proper "out" position by means of the adjusting screw *H*, which is held in the block *I*, fastened to the top member of the forging die.

In operation, the stock which has been heated for a distance of about 18 or 20 inches is placed in the impressions in the upper members of the stationary gripping dies. The machine is then operated; the gripping dies hold the work rigidly, while plunger *K* advances and forces sliding block *C* forward until it contacts with block *B*. The forward movement of the ram continues until block *B* is forced up against block *A*, when the ram recedes, the dies open, and the forging is removed. It is evident that as the work is held rigidly between the opposing faces of the gripping dies, the advance of these sliding members can only accomplish one result, which is to upset the excess metal allowed and expand it into the impressions provided in the dies, thus forming the bulges.

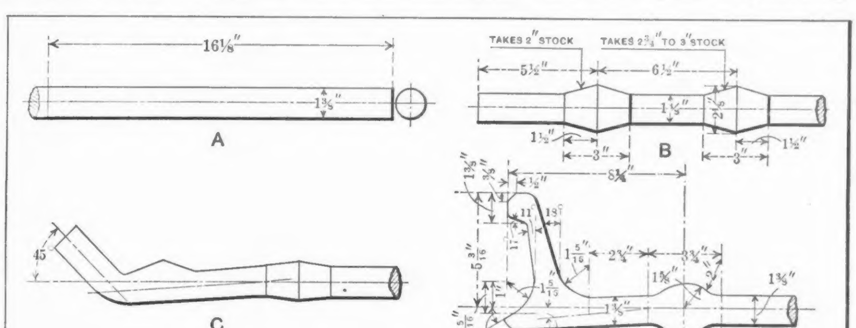

Fig. 61. Sequence of Operations on Ford Front Axle accomplished in "National" 3½-inch Forging Machine

The next operation on the front axle, which is indicated on the top of the axle at *C* in Fig. 59, and also at *C* in Fig. 61, consists in bending the end around in order to locate the material in the required position for forming the knuckles of

* The fourth installment of this series appeared in the July issue.
†Associate Editor of MACHINERY.

the axle. This operation is handled in the dies shown in Fig. 62, that member which accomplishes the work being formed on the top face of the top members of the dies. The bar, which is still in its initial heat, is laid on top of the dies and in contact with the stop gage *L*. The machine is then operated, and as the dies close, the impressions formed on the projection of the top die twist the end of the bar around and form it to the desired shape, offsetting it to an angle of 45 degrees in one direction and 5 degrees in the other.

The bar in this condition is now placed in the furnace and a steam hammer of the type shown in Fig. 63, the dies illustrated in Fig. 64 being used. As was mentioned in regard to the forging machine operations on this axle, only one end is completed at a time; this will be seen by referring to the dies shown in Fig. 64. The axle is heated for a little over one-half its length and is placed on the lower die in the steam hammer. The operator is careful to locate the end of the bar so that the stock to form the knuckles is in the proper position in relation to the impression in the die before the first blow is struck; then ten successive blows are struck and the axle is

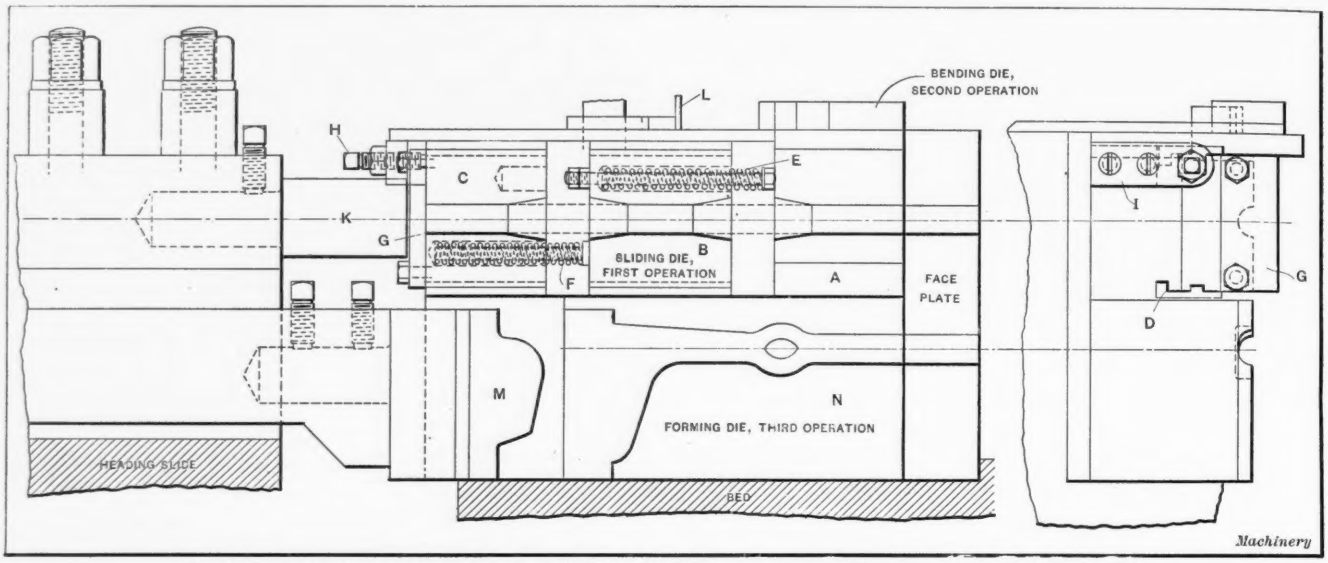

Fig. 62. Construction of Dies and Tools used in the "National" Forging Machine for making Ford Front Axle

again heated to the proper temperature. Then it is brought to the forging machine and placed in the lower impression in the gripping die shown in Fig. 62. The forging machine is then operated, and as plunger *M* advances, it upsets and forces the work into the impressions in the lower gripping dies *N*, forming the front axle to the shape shown at *D* in Figs. 59 and 61. This completes the operations on the front axle which removed and taken to a punch press holding a shearing die which removes the fins. The axle is then brought back to the steam hammer, given a final blow and laid down to cool off in the sand.

After one end of a batch of front axles has been finished in this manner, the other end is heated and carried through the operations described. The axles are again taken to the

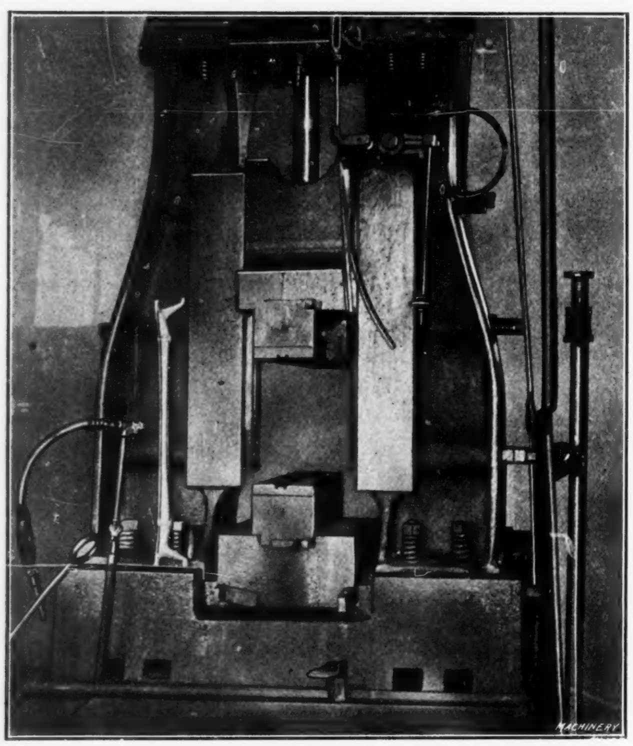

Fig. 63. "Massillon" Steam Hammer used for bringing the Ford Front Axle to Final Shape

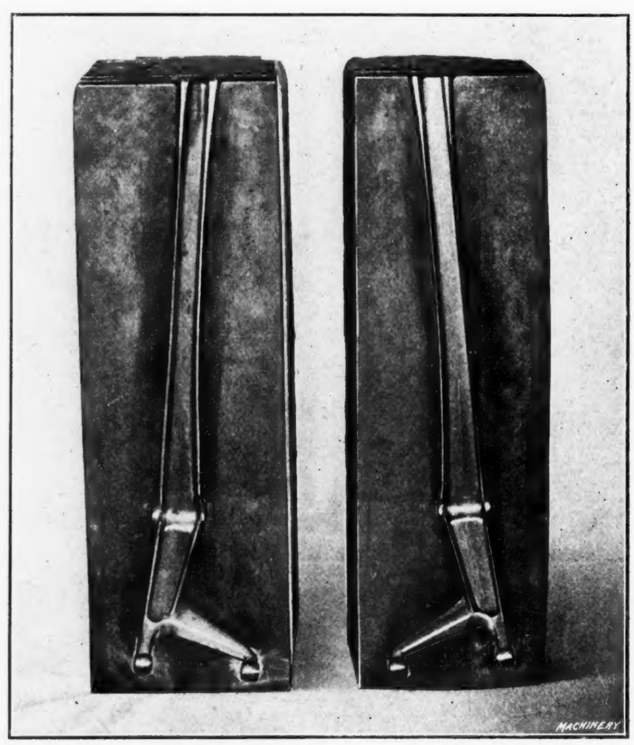

Fig. 64. Upper and Lower Dies used in Steam Hammer shown in Fig. 63 for finish-forming the Ford Front Axle

are handled in the forging machine. After one end of the bars has been formed to the desired shape, the other end of the bars is heated and passed through the operations previously described. Before the front axles are passed on to the final drop-forging operations, the burrs and fins formed in the forging machine dies are removed.

The final forming of the front axles is accomplished under furnaces, heated and placed in a fixture held in a punch press, where they are stretched to the exact length—52½ inches. The manner in which work of a similar character—drop-forging of crankshafts—was handled under the steam hammer was illustrated and described in an article entitled "Shop Practice of the Willys-Overland Plant," published in the March, 1913, number of MACHINERY.

Methods used in Welding Parts in the Forging Machine

There are three methods in general use for welding or joining pieces together in a forging machine, the one employed depending largely on the shape of the work and other requirements. The most common method in general use is lap-welding, of which there are several applications. The next method of importance is pin-welding, butt-welding as a rule being used only where it is impracticable to handle the work in any other way. An example will be given in a future article, however, of this class of welding, which is accomplished in an interesting and satisfactory manner.

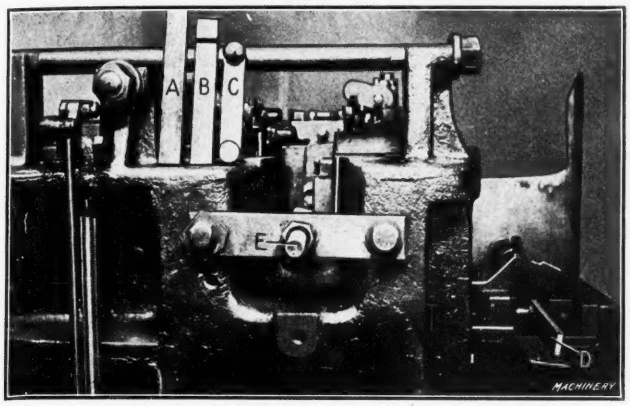

Fig. 65. Making Draw-bar Hangers in a 3-inch Ajax Forging Machine

In regard to the materials that can be handled, wrought iron can be very readily welded in the forging machine, and when proper care is taken this can be successfully done without resorting to the use of fluxes except in unusual cases. Machine steel does not weld as readily as wrought iron, and usually it is advisable to use a welding compound on the faces of the parts it is intended to join. The following ingredients make a satisfactory flux for steel welds: To one part of salammoniac add twelve parts of crushed borax. Heat slowly in an iron pot until the mixture starts to boil, then remove and reduce to a powder. Then apply the powder to the welding faces of the work shortly before removing from the furnace, putting the work back in the furnace for a short period after applying the flux. Alloy steels, while they can be worked successfully in a forging machine, cannot be welded, especially when great strength of parts is desired. As a rule, parts made from alloy steels can only be worked into shape by upsetting and forming.

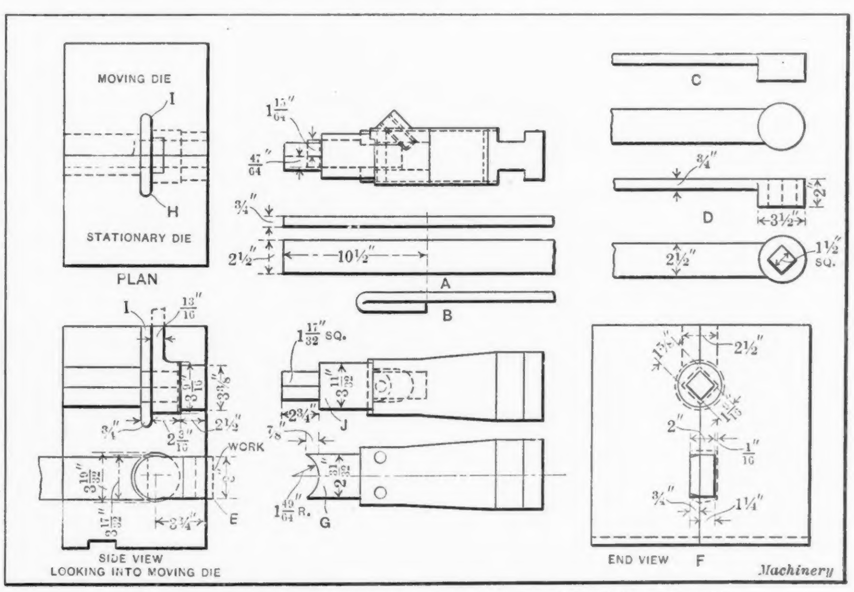

Fig. 66. Dies and Tools used in making a Locomotive Ash-pan Handle

Lap-welding and Forming Operations

A simple example of lap-welding in conjunction with a forming operation is shown in Fig. 65 where the various steps in the production of this part—known as a draw-bar hanger—are illustrated at *A*, *B* and *C*, respectively. The first operation consists in cutting a 2¼ by ¾-inch bar of wrought iron to a length of 19¾ inches—this allowing a sufficient amount of excess material to form the two bosses, one on each end. The bar is then heated in the furnace and placed in the side shear of the machine as shown at *D*. The forging machine is now operated and the tools held on the side shear arrangement partly cut off the bar and bend the nicked end around about one-quarter turn. It is then removed from the machine, placed on an anvil, and the bent end lapped over as shown at *B*, after which it is again put in the furnace and heated to the proper temperature; it is then removed and placed in the lower impressions in the gripping dies, being properly located for length by the back stop *E*. The machine is then operated, completing the weld and forming the upset square boss on one end of the bar in one blow. After performing the operations described on all of the bars, the other end is handled in practically the same manner, using the upper impressions in the gripping dies and subjecting the bar to three heats instead of two.

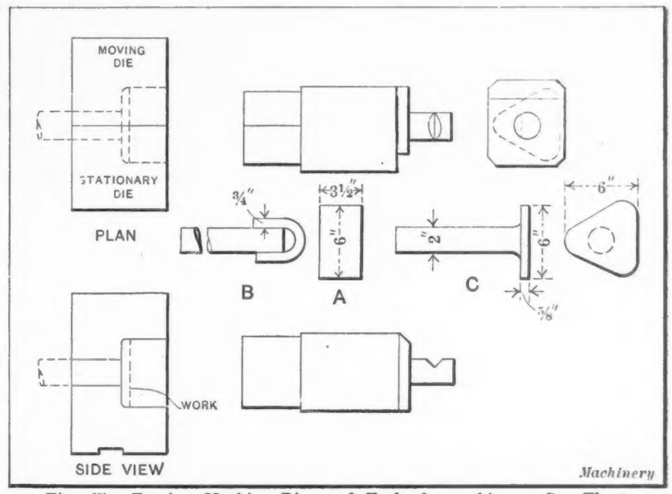

Fig. 67. Forging Machine Dies and Tools for making a Car Float Stanchion Foot

Dies and Tools for making Locomotive Ash-pan Handle

Fig. 66 shows a steam locomotive part known as an ash-pan handle that is produced in a similar manner to the draw-bar hanger shown in Fig. 65, the operations on this piece being indicated at *A*, *B*, *C* and *D*, respectively. The first operation is to cut off a bar *A* of the required length, as before mentioned, and bend one end over into the shape shown at *B*, putting it into the required condition for welding, forming and piercing in the forging machine. The welding and forming operations which are indicated at *C* are handled in the lower impression of the dies shown to the left of the illustration, the position of the work before forming being indicated by the heavy dotted lines *E*. The lower impression is formed as shown in the end view of the dies at *F*, being provided with a draft in the impression of 1/16 inch on the diameter in order to facilitate the "flow" of the metal and the removal of the forging from the dies. The punch *G* is made with a concave end which forms a portion of the boss and upsets the material into the desired shape at the same time.

After being welded and formed, the work is removed from the lower impressions and placed in a vertical position in the upper impressions in the dies. Here the square hole, as indicated at *D*, is punched. As the gripping dies are made from steel castings, they would not stand up satisfactorily for a piercing operation, so in order to punch a clean hole two steel plates *H* and *I* are inserted in the movable and stationary members of the dies. These are so shaped that a square hole is formed when the dies come together. The hole is pierced by the punch *J*, the construction of which is clearly shown in the illustration. Both punches *G* and *J* are made from steel forgings and hardened.

Dies and Tools for making Car Float Stanchion Foot

Another interesting example of lap-welding which is used for the purpose of enlarging a 2-inch bar to 6 inches in diameter to form the head on a car float stanchion foot is illustrated in Fig. 67. This car part in the initial stages of manufacture as indicated at *A* and *B* is made from a wrought-iron bar 2 inches in diameter, to which a rectangular block *A* 6 by 3½ by ¾ inch is welded. The block *A* is first cut to the required length, and bent into a U-shape in the bulldozer. Then it is placed on the round bar as indicated at *B*, and the two parts are put in the furnace, where they are heated to a welding temperature. The parts are now quickly removed, given a tap to stick them together, placed in the forging machine, and with one blow are formed to the shape shown at *C*. The dies and tools used for this operation, which are also shown in the illustration, are of simple construction, consisting only of two gripping dies and one plunger.

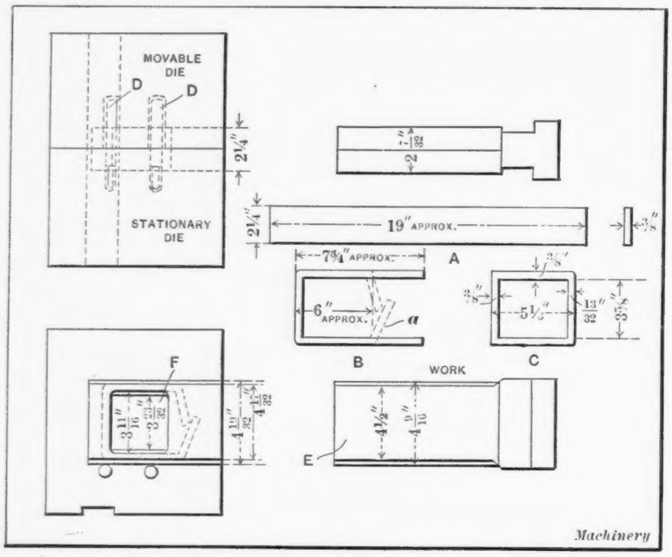

Fig. 68. Forging Machine Dies and Tools for making Locomotive Spring Bands

Dies and Tools for making Locomotive Spring Bands

A lap-welding operation which is handled in a different manner from those previously described is shown in Fig. 68. This piece, which is a spring band for a steam locomotive, is made from a rectangular wrought iron bar 2¼ by ⅜ inch by approximately 19 inches long. It is first bent into a U-shape as indicated by the full lines at *B* in a bulldozer. This part, after being bent in the bulldozer, is again put in the furnace and heated to the proper temperature. It is then removed from the furnace, and by means of bending dies held in the side shear of the forging machine, the ends are bent into the shape shown by the dotted lines *a*—partly overlapping each other. After this operation, the piece is again placed in the furnace, heated to a welding temperature, and quickly removed and placed between the gripping dies shown to the left in Fig. 68. The stationary gripping die, as illustrated, carries two pins *D*, which serve as a means for supporting the work before the dies close on it. The welding and forming operation is accomplished by the plunger *E*, which forms the work around the square impressions *F* in the dies, and at the same time welds the two ends together, forming the spring band into one piece. A particularly interesting feature about this job is the fact that the excess amount of stock formed by the overlapped ends is distributed equally along the front side of the forging, making it 1/32 inch thicker than the original rectangular bar, and thereby increasing its strength at this point.

Dies and Tools for making Extension Handle for Grate Shaking Lever

An interesting example of lap-welding is illustrated in Fig. 69, where the dies and tools used for forming an extension handle for a grate shaking lever are illustrated. This part, as shown at *A* and *B*, is made from two pieces—a rectangular bar of wrought iron 2½ by ¼ inch, which has been sheared to an angular shape on one end—and a loop *B* formed from a piece of ⅝-inch rectangular bar iron bent into a U-shape in the dies illustrated to the left. The trimming of the piece *A* and the bending of the piece *B* is carried on at the same time with special shaped formers held to the top faces of the gripping dies. To do this the operator first places a piece of rectangular stock of the required length in the impressions in the rear member *D* of the stationary gripping die; he then takes the bar *A*, which has been previously cut to the required length, and places it in the impression at the front end of the gripping die. Upon operating the machine, the moving die advances and as it carries a plunger *E* it forces the bar *B* into the suitably shaped impression in the stationary gripping die. At the same time that this operation is being accomplished the shearing plates *F* and *G* carried in the stationary and movable gripping dies, respectively, shear off the end of the bar *A*.

The welding of these two parts is accomplished in the lower impression in the gripping dies which hold the pieces in position while the punch *H* advances and upsets and welds the parts together. The manner in which this operation is accomplished is as follows: The two pieces are placed together and put in the furnace, heated to a welding temperature, then removed and given a tap, so that they are stuck together. They are then put in the lower impression of the gripping dies and the machine operated. Then as the plunger *H* advances it enters the loop in the part *B* expanding it into

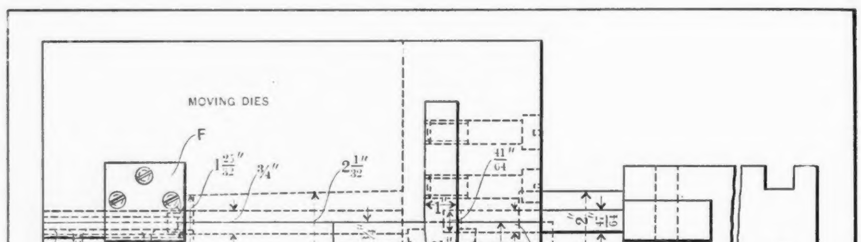

Fig. 69. Forging Machine Dies and Tools for making Extension Handles for Grate Shaking Levers

the impressions in the gripping dies, and at the same time by means of the shoulder on the punch carrying forward the excess stock and distributing it equally throughout the forging, thus joining the two parts and producing a perfectly welded joint. The punch *H* is guided when in operation on the work by a tongue *I*, which slides in a corresponding groove in the gripping dies, and thus prevents any side movement of the punch.

* * *

DON'TS FOR DRAFTSMEN*

BY MAURICE W. FOX†

Don't buy opaque triangles or curves.

Don't try to economize by buying thin tracing paper.

Don't work in an office where you are learning nothing.

Don't use a knife on tracing cloth except for a rough job.

Don't tap into a heavy casting when you can use a through bolt.

Don't draw outlines before you have laid out the center lines.

Don't waste money on cheap drawing instruments—they soon wear out.

Don't use irregular curves when arcs and straight lines will answer.

Don't always ask your neighbor to sharpen your pens—learn how yourself.

Don't design long, light parts that may be broken in shipment or handling.

Don't connect a straight line to a curve except at the point of tangency.

Don't use too hard a pencil—the tracer will have trouble finding the lines.

Don't expose heavy castings to friction—use renewable pieces to take the wear.

Don't use first-angle projection—third-angle projection is now almost universal.

Don't buy a T-square that is not equipped with an adjustable head and transparent edges.

Don't work in an office where you consider yourself superior in ability to the men over you.

Don't buy an irregular curve that does not have a fairly long portion that is almost straight.

Don't put light projections on heavy castings where they are likely to be broken off by accident.

Don't get sore because somebody offers a criticism, or destroy his friendship by an impatient remark.

Don't get mad when asked to make changes—very few drawings are approved in their original form.

Don't make anything elliptical when two halves of circles connected by straight lines will do as well.

Don't think that the concern has employed all the fools or all the experts there are in the business.

Don't detail a lot of special stuff when standard goods can be ordered as well out of a supply catalogue.

Don't make the small gears stronger than the large ones—it is cheaper to replace small ones if they break.

Don't forget elementary principles—they hold good in the greatest structures and most complex machinery.

Don't forget, if you roll up a tracing, it will have an annoying curl in it when you want to lay it out flat again.

Don't draw castings too large or complicated to be easily made or handled—consider dividing the piece and using bolts.

Don't think the chief draftsman incompetent because he does not possess the combined knowledge of all the men under him.

Don't forget that light sections will rust through faster, and cost more to paint, per unit of weight, than heavy sections.

Don't forget that the present tendency is to use nothing but capitals—also to cross-hatch all materials with simple parallel lines.

Don't bear on too hard, or rub too vigorously, or use a sandy eraser in removing ink—with due care the original surface of the cloth can be restored.

Don't think you are an expert just because you once worked for some famous firm—every concern employs men of varying abilities.

Don't tell every newcomer what a dub you are working for—he cannot do his best work without confidence in his employer.

Don't think the professors in your college are the greatest engineers on earth, nor that their books are standards in every nation.

Don't forget that tracing paper is more easily torn and split than tracing cloth, but is cheaper, and lines are more easily erased from it.

Don't think a man is wholly useless because some other man is knocking him—reserve your opinion till you know both sides of the case.

Don't try to design complicated or highly standardized machinery unless you have had wide experience which fully equips you for the task.

Don't try to draw with the point of your ruling pen too close to the triangle—hold the pen vertical, or inclined in the direction of the line you are drawing.

Don't forget you can convert a "right hand" into a "left hand" by tracing the design and the lettering on opposite sides of the cloth or tracing paper.

Don't think that this or that expert produces nothing but perfect designs—check his work with what data you have and don't be afraid to look for improvements.

Don't think you have to have a row with the boss before you resign—leave every job with the good will of the concern and the chance to come back if you wish.

Don't think you are a "draftsman de luxe" because you have a lot of useless drawing instruments and curves or a stack of text-books that you never get time to read.

Don't think that every good designer came from your "neck of the woods"—able men have originated in every part of this country and in every foreign country as well.

Don't forget that nominal diameters and actual diameters of wrought iron pipe are entirely different, and that the actual dimensions can easily be found in catalogues and handbooks.

Don't start extensive erasing on a tracing without considering the method of making a negative and painting out a part with India ink—new lines can be drawn on the positive which is made from the negative.

* For Don'ts previously published in MACHINERY, see "Don'ts for Drill Grinders," July, 1913, and "Don'ts" there referred to.

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* * *

POWER FROM DAM BUILT FOR IRRIGATION

The great Assuan Dam in Egypt was begun in 1898 and was completed, as originally planned, in 1902. It was built to impound the waters of the Nile and make them available for irrigation. The original dam impounded 980,000,000 cubic meters. The benefits of the extensive irrigation water supply made available by the dam were so great that in 1905 the government authorities decided to increase the storage capacity by making the dam higher and thicker, thus increasing the storage capacity to 2,500,000,000 cubic meters. The thickening and heightening of the dam was begun in 1907 and was completed in 1912. Plans are now being made for the utilization of power from the waste water flowing through the sluices. This power will be used in part for producing nitrates for fertilizer and will thus additionally contribute in restoring the fertility of the arid fields of ancient Egypt.

* * *

SPEED OF EARLY RAILWAY TRAINS

A locomotive steam engine, constructed by Davis and Garther, of York, Pa., commenced her operation on the Baltimore & Ohio Railroad under the most favorable auspices on Tuesday. It started from the Pratt street depot for Ellicott's Mills, with the entire train destined for that place, consisting of 14 loaded cars, carrying, together with the engine tender, a gross weight of 50 tons. The whole went off in fine style and was soon out of sight. A gentleman present says it was out of sight of the depot in about six minutes, and the rapid gliding of the immense train was one of the most imposing and most beautiful spectacles he ever witnessed.—*Extract from the National Gazette, published in the American Railroad Journal of July 28, 1832.*

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GRINDING FORMED CUTTERS

Joseph Brown's invention of the formed milling cutter, which can be ground without changing its shape, was a great advance in milling machine practice, and it is safe to state that the milling machine as a factor in interchangeable manufacture would never have become as important as it now is if all formed cutters were to lose their original shape when sharpened. The cost of maintaining cutters would be prohibitive for many classes of work on which they are freely used. The most important of the formed milling cutters are those used for cutting gears, and it is very essential that the original shape be maintained throughout their working life, because slight deviations from the original shape that would pass unnoticed with other formed cutters become very apparent in cut gears. Inaccurate tooth shapes and lack of concentricity of the pitch circle with the mounting shaft are the two chief causes of unsatisfactory action of gears cut with the common gear cutter.

To grind a gear cutter so as to preserve the original shape is not an easy matter unless better means are provided than are found in most machine shops. In the first place the cutting face must be ground truly radial; a pitching of the face ahead or back of the radial line changes the projected shape, and as it is that which defines the outline of the cut, the result, of course, is a departure from the established tooth shape. To grind radial faces with a cutter grinder is comparatively easy, and if this were the only requirement to produce perfect working cutters the problem were easily solved, but the heights of the teeth must be equal. This, too, could be readily accomplished by using an indexing fixture if the cutters were truly round and evenly spaced. These conditions are seldom realized, however. Changes of shape in hardening throw the teeth out of even spacing, and if ground on an accurate indexing fixture some of the teeth will be so short that only a few do the cutting. The result is rough work and heating of the cutter which reduces the quality and quantity of gears cut.

A cutter grinder recently put on the market employs a new principle of indexing—new in the sense that it is unknown to most mechanics. The teeth are indexed by a finger resting on the *back* of the formed part, an indicator being provided which enables the operator to gage the position of each tooth with reference to its own shape as well as to the axis of the cutter, within a thousandth inch or less. Each tooth face is ground truly radial and all the teeth are ground to the same height.

In the operation of this machine, the curious fact has developed that few machinists or toolmakers apparently understand the machine, although it is simple, because they have never taken the trouble to study the fundamental principles of efficient formed cutter action. This condition is hardly creditable to American mechanics, who pride themselves generally on being quick to grasp machine principles and apply them.

* * *

IMPROVED MACHINERY AND THE WORKMAN

The boilermakers' union in England is engaged at the present time in a campaign opposing the use of the oxy-acetylene blow-pipe for cutting boiler and ship plates. The union has passed resolutions limiting the number of machines used in proportion to the number of men employed, and forbidding the use of the machines when working over-time. Fortunately, the opposition to improved methods and machinery on the part of the men that are to use them is not as frequently met with in this country as in England; but there are enough instances on record to justify a word on the subject.

The idea that the introduction of machines for performing work which has previously been carried out by manual labor is detrimental to the best interests of the worker at a trade, is deeply rooted in the minds of a great many people. They apparently believe that there is just so much work to be done in the world at any given time, and no more. This attitude of men who work mainly with their hands was in evidence at the time when the earliest types of machines were introduced. The weavers in England fought the introduction of the mechanical loom; the sewing machine was opposed by the tailors; the molding machine, by the foundry workers. Of course, examples can be cited where the introduction of machinery has temporarily thrown a number of men out of work, but in the long run the community in general and these men as well have benefited. Taking a familiar example, it is beyond question that thousands of men who could have been employed on the farms in the United States are now displaced by our modern agricultural machinery; but is it reasonable to expect that the average standard of living would be as high as it is if all the farm labor were performed in the manner of a century ago? Improved machinery makes it possible to produce more quickly and cheaper, and, hence, should be a benefit to all. If it can be shown that in spite of the improved machinery the products are not sold any cheaper to the ultimate consumer, then the system of distribution and some other economic problems yet unsolved are responsible. Improved machinery is not at fault.

* * *

FAILURES THAT BECOME SUCCESSES

The fact that a method or machine is unsuccessful is not necessarily a proof that the principles involved are wrong. A new material or a new process of manufacture may so change conditions that an unsuccessful device becomes commercially practicable. The aeroplane, for example, became a possibility only after the internal combustion engine had been highly developed. The wish to navigate the air has been a dominant impulse of man in all ages, but although numerous models had been made, all were doomed to failure because of the lack of a practicable motive power. With a modern gasoline engine, Darius Green's "experiment" might not have ended so disastrously.

A common fault of tubular magazine rifles was the danger of explosion of the cartridges in the magazine from the impact of the bullet point of one cartridge on the primer of the cartridge ahead of it. Numerous schemes had been devised to obviate the defect, but none were considered successful. Magazine tubes having an internal spiral or thread to throw the cartridges out of line, had been tried but found faulty when used with the old form of military cartridge having a rimmed head. But with the rimless cartridge, the scheme works successfully. Shaving dies operate badly on some materials—drill rod, for example; when pressure is applied steadily, the metal is torn and left rough, but when the impelling force is applied as a series of blows, smooth cutting action results. Hence, the use of the pneumatic hammer to perform a shaving operation on drill rod that was found to be impossible when the power was applied by a press.

Many of us are cursed with the knowledge of things that are not so. We believe that experience has demonstrated that certain processes are impossible, whereas they are simply impossible when all the conditions are as they were in the original experiment. Modify one or more of those conditions and the impossible may become not only possible, but practicable. The progressive man has to learn to profit by the experiences of others, but he must also be a doubter of the accuracy of some recorded work to the extent of being willing to repeat it under new conditions with faith that different results may be obtained.

* * *

CHATTER IN MACHINE TOOLS

Given ample driving power, the efficiency of a machine tool in cutting metal may be said to be inversely proportional to its lack of rigidity. Logically, this should be stated as directly proportional to rigidity; but as no mechanism has a rigidity of one hundred per cent—that is absolute rigidity—we cannot draw a comparison between present realization and the ideal. The ideal in rigidity does not exist, and no one knows what the conditions would be if absolute rigidity of tool and work support could be realized. We simply know that weakness of the tool support and driving train causes excessive chatter. The stiffer these are, the smoother the cut, but in the best designs the tendency to chatter is likely to develop with heavy cuts and high speeds.

The purpose of machine tools is to force cutting tools through metal. The machinery and tool supports are solely for holding the tool against the work and driving the tool or work so as to take a progressive cut. When that object is accomplished in accordance with the requirements of the case, the designer's work is done, except that convenience of attendance, appearance, etc., must also be considered. These, however, are minor in comparison to the prime essential—presenting the work and tool in opposition, with ample driving power and the maximum rigidity of support that can be attained.

But a great difference may exist between two machines of the same weight and driving power as regards rigidity and tendency to chatter. This difference is due to friction of bearings and proportions of parts, which brings us to a consideration of the laws of vibration. A lathe, for instance, may chatter excessively when turning a piece of a certain diameter and using a tool ground to a certain shape. A change of cutting angle, lowering or raising the tool, running with open belt instead of back-gears, or other changes of the several factors involved, may promote smooth cutting.

Here is an opportunity for profitable investigation to determine what are the conditions of weights, torsional strength, cutting angles, hardness, etc., that tend to cause excessive chatter, or better, what proportions and arrangement of driving parts tend to produce the least vibration. Taking the typical engine lathe as an example, mechanics know that the smoothest and most accurate turning work is produced when running with an open belt. Chatter marks are more likely to show when the back-gears are in action. The difference is commonly attributed to irregularity of gear tooth action, but is it not largely due to lack of torsional rigidity of the back-gear quill? Tests have demonstrated that placing the two back-gears close together causes a great difference in the stiffness of drive. This probably is only one of the weaknesses not commonly known that could be eliminated in the engine lathe or milling machine.

* * *

After the recent floods in Ohio had subsided, a well-known machine tool builder received a request to overhaul some boring mills of his make, installed in a rubber plant. The workman sent found that the bearings were excessively worn and that new bushings were required for all the principal bearings. The wear was so abnormal that he made inquiries regarding the lubrication and discovered that the men were not allowed to use mineral or animal oils for lubricating their machines but could use linseed or cottonseed oils only. The lubricating properties of linseed and cottonseed oils are practically nil and the wonder is that the bearings were not worn worse than they were. Situations which demand the use of vegetable oils exclusively, would seem to require, for efficient up-keep, the use of ball bearings.

COST ESTIMATING IN MACHINE CONSTRUCTION

BY A. C. JEWETT*

Cost estimating varies in difficulty according to the nature of the work for which the cost is to be determined. In the larger engineering contracting and construction work, considerable data are available in the form of published records of work done and of bids submitted. Such data are not available for estimating manufacturing costs and it is doubtful if data collected in one plant could be utilized with safety in another, inasmuch as operations are far from being standardized and the elements of cost vary so greatly in different plants. In the course of time scientific management may bring about a standardization of machine operations and the establishment for such operations of unit times which may be of direct value in making estimates, but as yet nothing of this sort is available for factories in general. In most manufacturing concerns it is customary to keep careful records of all costs for various purposes. These data are analyzed and tabulated for use in estimating the probable cost of a new machine. For certain classes of work unit prices can be established, such as a pound price for castings, but in a larger part of the work it is hardly possible to fix a unit price. In such cases the probable cost, of machining for example, is estimated by finding what it has cost in the past to make some similar detail.

The factors affecting the cost of a machine are labor, material, and overhead expense. In producing a machine of new design the costs may divide themselves into the following classes: (1) Patterns; (2) Castings; (3) Machining; (4) Assembling. The cost of patterns depends upon the amount of lumber used and the time consumed, which will vary with the size and intricacy of the part. The cost of castings depends upon the difficulty of molding, the kind of metal and the number of castings to be made. The cost of machining depends upon the kind of material, the superficial area to be machined, the quantity of stock to be removed, the nature and accuracy of finish required, the intricacy of the work and number of pieces to be finished. The cost of assembling depends upon the size and intricacy of the machine and the accuracy of the workmanship upon its parts, which determines the amount of time which must be consumed.

The methods of estimating cost of manufacture may be based upon: (1) A straight pound price, or curve of comparisons; (2) The shop foremen's estimate of time and material, with burden added; (3) The bill of material, time records and machine rates determined from other work performed, plus burden. The following examples of these methods are taken from statements supplied by some of the larger manufacturers and may be considered typical of the practice in many concerns:

(1) The cost of machines of various sizes and known weight, which have already been built, is taken from the regular shop cost records. The costs per pound are computed and plotted as one coordinate and the total weights of the machines as the other. When enough data are available to establish the curve from various sizes of machines previously built, it may be used with considerable accuracy in predicting the cost of a similar machine of any estimated weight. If the machine has a certain degree of resemblance to established types, the established cost is taken and modified to suit the new features by an amount which these may seem to warrant.

(2) When a machine of new design is contemplated, drawings and specifications of which have been completed, a conference is held at which the works superintendent, the machine shop superintendent, the foundry superintendent, the superintendent of the pattern shop, and the chief engineer are present. The drawings and specifications are examined, and the superintendent of the foundry expresses his views regarding the molding of the cast pieces in the design, indicates where the design may prove impracticable from his standpoint, and makes suggestions whereby the cost of molding can be reduced. It is considered that the foundrymen must necessarily be consulted on a large part of the work, as to

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the best method of constructing the pattern with reference to molding.

The superintendent of the pattern shop estimates the amount of lumber that will be cut up in constructing the pattern and the time required to build it. The cost of the pattern is then determined from the price of the lumber and the rate of the patternmaker. The cost of the castings is based upon a price per pound, which price has been determined from costs covering a considerable period. The engineering department furnishes estimated weights of the parts, so that the cost of the castings is obtained. The time of machining the work is estimated by the superintendent of the machine shop and, from previous cost records, the cost of machining is determined from the time. The assembling is also estimated by the superintendent of the shop or by one of his foremen, and the actual stock and labor cost of the product is obtained. Such parts as machine screws, that are purchased from other concerns, are easily figured from the purchasing department's records. The stock and labor costs are kept separate. It has been found in many plants that the labor cost should be increased by 100 per cent and the stock cost by 10 per cent to cover overhead charges. To the total is added 15 per cent for profit, to give the selling price. From the estimated weight and the estimated selling price, the price per pound is secured and compared with the price per pound of other machines on the market of a similar nature or design. By this method a check is made upon the estimated figures. If it is found that the price is going to be entirely out of reason with those of competitors, a revision in the design is made to reduce the cost.

A similar method, with certain variations, is followed in many other plants. In some the overhead charges are isolated for the separate shops. For instance, one plant adds twelve cents per hour-man to the material and labor cost to obtain the cost of patterns. In some cases the cost of patterns is considered a part of the overhead charge or expense. To the cost of molding, plus the pound price of iron, plus labor is added 80 per cent of the cost of labor and iron to obtain the cost of the castings, which is reduced to a pound price. This cost also includes the cost of special flasks or rigging. The machining time is figured at the actual price paid the men plus an overhead shop charge of twenty-two cents per hour. The cost of special tools, jigs or fixtures is figured in the same way and added in. The profit is commonly added by an executive officer. The amount of the profit to be added is determined by considering the various circumstances surrounding the particular job in hand, being varied by the probable competition, the risk of spoiling or losing any of the pieces handled, the payments and numerous other items.

(3) A consulting engineer who is an executive of a plant which has been very successful with the Taylor plan of management has said, in substance, the cost of manufacture of machines of new design may be determined by making a complete detailed analysis of the work to be done, basing the time upon elementary time units; in short, making up the time for each operation just as it is done in setting tasks on work that is to be done in the shop. Arrive at the cost of material by making careful estimates of the weight of the castings and other materials entering into the machine. Add a proper proportion for indirect expenses. The principal objection to so detailed an estimate is that it is rather expensive. Unit prices can only be developed where the line of machinery is of the same design and type of construction, the differences being chiefly in size. For work of this nature a unit price per pound of the machine's weight may be used where it is not necessary that an estimate should be very accurate. Such a unit is useless when applied to machines totally different in design and construction. The cost per square inch is also useless if accurate results are to be achieved, as the proportion of cost in relation to the number of square inches to be machined differs widely, depending upon the nature of the surface, the form of the part, difficulties encountered in setting, the number of pieces of each kind to be machined, etc. While many of these makeshift methods serve the purpose, it is only because a rather wild guess is good enough by reason of there being a comparatively wide margin, or because their application is restricted to estimating machinery of a very similar nature.

TURNING CAMS ON A LATHE

An ingenious method of turning cams on a lathe is used by the Carpenter-Tew Gear Co., Brooklyn, N. Y., and could be adopted by many shops which occasionally have to cut cams of the type shown in Fig. 1, but do not have enough work of this kind to warrant buying a cam machine or a cam cutting attachment for a milling machine.

The type of cam turned by this method is illustrated in Fig. 1, where it will be seen that the hub *A* is concentric with the surface *B* of the cam. The bore of the hub is also concentric with the surface *B* but the center of the surface *D* of the cam is 7/8 inch from the center about which the surface *B* is turned. These cams are made of 5-inch machine steel stock. Blanks for this purpose are sawed from the bar and set up in the

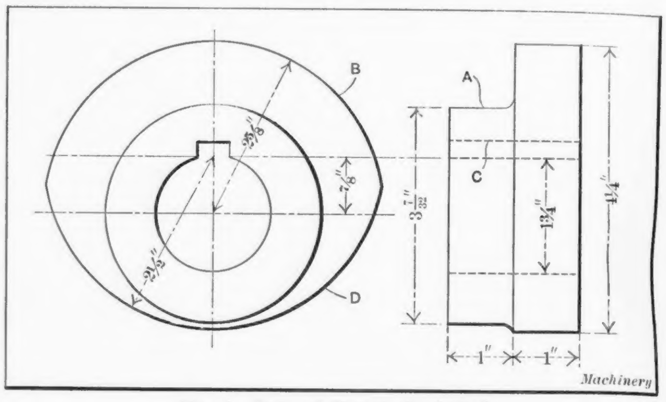

Fig. 1. Type of Cam to be turned

lathe, where the first operation consists of turning down the blank to form the hub *A*. The hub is then bored, after which the cam surface *B* is turned. After these operations have been completed on all of the blanks, the work is transferred to a slotter where the 1/2-inch taper keyway *C* is cut in each piece.

After the work has progressed to this stage, the final step consists of turning the cam surface *D*. For this purpose, the fixture shown in Fig. 2 is used. This consists of a plate which is bolted to the faceplate of the lathe by bolts fitting in the two slots. It was previously mentioned that the center of the surface *D* is 7/8 inch from the center about which the surface *B* was turned. Consequently the fixture is set 7/8 inch off center. The work is held on the stud *B*, the key *C* being provided to fit into the keyway which was machined in a

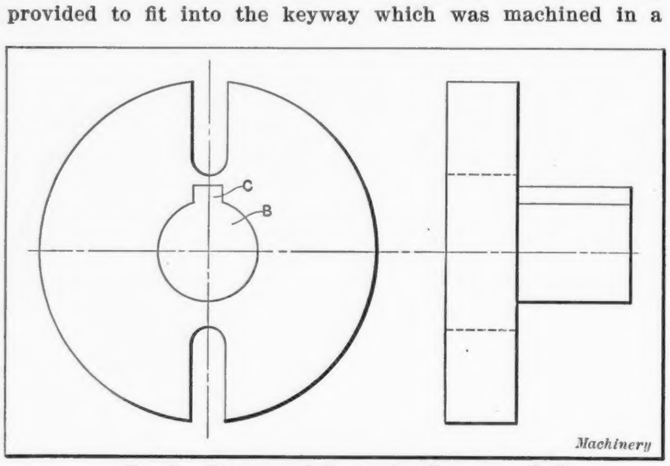

Fig. 2. Fixture used for turning Cams on a Lathe

previous operation and prevent the work from turning on the stud. The successive blanks are then mounted on this fixture, when it is an easy matter to turn the surface *D*. Referring to Fig. 1, it will be seen that there is an edge at the two points where the surfaces *B* and *D* meet. After the surface *D* has been machined, a file is applied to the work to reduce these two edges so that the roller will run smoothly when passing around the cam. These cams are used on a well-known printing press. E. K. H.

* * *

Curious incongruities are sometimes noted in plant management. Pattern lumber stored in the open air while chips and other metal refuse are kept under cover, is an example.

AN EARLY AUTOMATIC GEAR CUTTING MACHINE

A RECORD OF IMPROVEMENTS MADE IN GEAR CUTTING MACHINERY IN THE SHOPS OF R. HOE & CO., NEW YORK

BY DOUGLAS T. HAMILTON*

Little is known of the early development of automatic gear cutting machinery for the simple reason that no authentic records were kept, and no patents had been taken out before the early eighties. What is supposed to have been the first full automatic gear cutting machine was developed in the plant of R. Hoe & Co., New York City, makers of web printing presses. This first machine was evolved from a hand-operated gear cutting machine built by the Freeland Tool Works, New York City. The factory in which these early gear cutters were built was closed years ago; it was located on 34th St. between Tenth and Eleventh Aves. This first machine in its remodeled condition—converted into an automatic gear cutting machine—is shown in Fig. 1. When originally built it only had a down feed for the cutter slide, which had to be raised by hand, and the machine was indexed in a similar manner. The method of operating was to draw up the cutter slide with the left hand by means of the handwheel and ratchet at the top of the feed-screw, and index the work with the right hand.

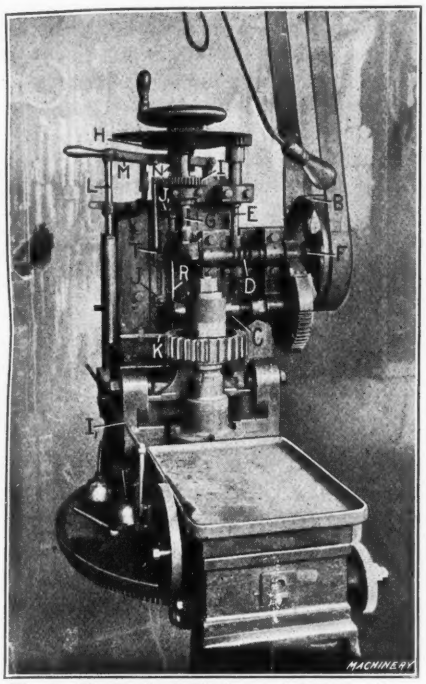

Fig. 1. Old Freeland Hand-operated Gear-cutting Machine, converted into an Automatic Gear-cutter

The Freeland gear cutting machine, as originally built, was supposed to be accurate as regards indexing, but after many tests were made of gears cut on this machine, it was found that the spacing of the teeth varied. As the work turned out was not of the required standard for the Hoe printing presses, Colonel Robert Hoe set about to develop this machine and make it much more accurate. The first step in this direction was to make an accurate dividing wheel, which is shown in Fig. 6. This dividing wheel was made from an iron casting of the shape shown, and was machined on its circumference providing a ledge as indicated in Fig. 7. Against this ledge 180 cast-iron blocks *B* are held by screws *C* and toe-clamps *D*. These blocks, which are slightly over one inch in length, were scraped to fit a gage, the sides of which were beveled to about 0.010 inch in the height of the block. When the 180 blocks had been finished to the desired size the cast-iron wheel was turned to approximately the required diameter and then the cast-iron blocks fitted to it. This procedure was followed until the circumference of the turned portion on the wheel was such that it exactly contained the 180 blocks. The diameter of the dividing wheel over the clamps is about 63 inches, and the separate sections or blocks are about 3/16 inch thick.

Obviously the making of this dividing wheel required the most painstaking work and consumed considerable time, as is evident from the statement that it took two years to complete this wheel, which was finished in 1879. After producing the master dividing wheel, the next step was to make the indexing or dividing wheels to be used on the Freeland gear cutter shown in Fig. 1, and also on others that were built later. These dividing wheels were cut on the old Whitworth machine shown in Fig. 5. The dividing wheel was placed on the rear end of the work arbor *A* and the wheel to be cut took the place of the work. The teeth were produced with a special shaped cutter, which was kept as sharp as possible.

The manner in which this dividing wheel was cut is as follows: The operator removed one of the blocks *B*, Fig. 7, from the master dividing wheel and located the indexing plunger in the space from which the block was removed. Then he cut one tooth space, using a very fine feed so as not to heat the work. When this was completed, the block was put in place and another block removed from a point on the circumference of the wheel diametrically opposite to the position from which the first block was removed. The wheel was then turned around and the locking plunger put in the place previously occupied by the block, whereupon the second tooth space was cut. Following this the wheel was divided into quarters, eighths, etc., until all the teeth were cut. In all cases the indexing was made from positions diametrically opposite in order to reduce to a minimum inaccuracies due to temperature conditions. After the teeth were roughly cut, the gear was put away to season and was then set up again and a light finishing cut taken. Some idea of the care taken in cutting these wheels may be gained from the fact that it required nine months to complete seven wheels. The room in which these wheels were cut was kept at a uniform temperature of 70 degrees F. by a fan. At the time that the master dividing wheel was made seven index wheels were completed, six of which were later used on machines built by R. Hoe & Co.

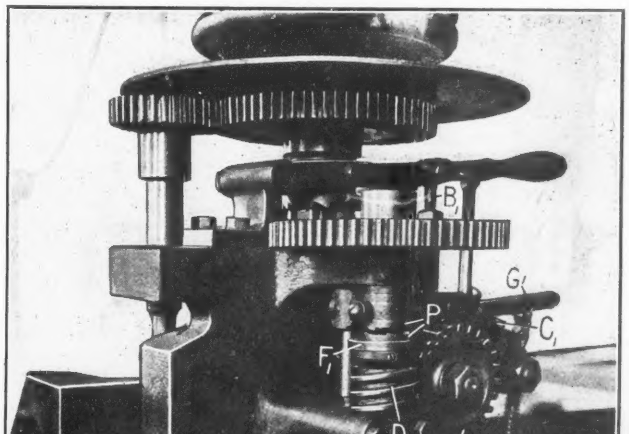

Fig. 2. Rear View of Machine shown in Fig. 1, showing Portion of Indexing Mechanism—an Improvement made by R. Hoe & Co.

The changing over of the Freeland hand-operated gear cutting machine into a fully automatic machine is credited to William Hall, who at that time had charge of the gear cutting department. The first improvement was made in 1880 by Mr. Hall and consisted of a device to provide an automatic stop and return for the gear cutter slide. Later he devised an attachment for indexing the work. The automatic stop and return for the cutter slide worked satisfactorily, but the indexing attachment did not. Trouble was caused by its fre-

*Associate Editor of MACHINERY.

quently failing to slip and preventing the work from indexing the full amount, thus of course, spoiling the gear. About the year 1882 Joseph Buckley, who was also employed in the gear cutting department, put on a safety device which stopped the down feed of the cutter slide when the indexing mechanism had not operated properly. This stopped the feeding down of the cutter slide, and prevented the gear from being spoiled.

The Whitworth Gear Cutting Machine

The gear cutting machine shown in Fig. 5, which was built by Joseph W. Whitworth & Co., Manchester, England, was the first machine to be employed in the shop of R. Hoe & Co. for cutting gears.* This machine was used for several years before the Freeland machine was purchased, and as the Freeland machine was considered somewhat better as a manufacturing proposition, the same developments were not made on the Whitworth that were made on the former machine. This Whitworth machine stands today practically the same as it was when originally built. It is indexed by hand, by means of the handle B and shaft C, then through change gears D to a shaft at the rear, which carries a worm that meshes with the dividing wheel E. The handle B is rotated the required number of times and is then located in the disk F which has four notches. The dividing wheel E is keyed to the arbor A holding the work and in this way the work can be indexed for the cutting of each successive tooth. Considerable trouble was encountered in indexing this machine, owing to the fact that the operator had to depend only on the four notches in disk F, and when it was necessary to make an odd number of divisions the handle could not be locked and hence was not accurately located. To provide against improper indexing, Joseph Buckley put on a safety device which worked satisfactorily. A worm-wheel was fastened to shaft C and a bracket T was attached to the bed of the machine. This bracket carried a shaft on which a worm was held, meshing with the worm-wheel, and also three indexing cams having three, four and five grooves, respectively.

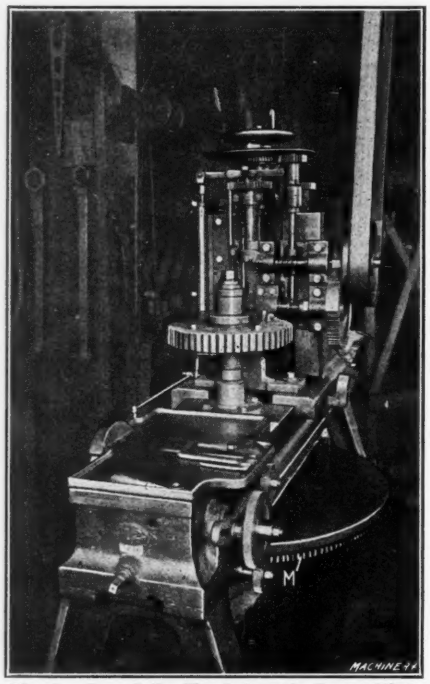

Fig. 3. One of the Six Automatic Gear-cutting Machines built by R. Hoe & Co., patterned after the Freeland Machine

Now when the operator rotates handle B it is necessary for these cams (only one of which is brought into use to give the desired number of divisions) to rotate into such a position that the rod U will drop into one of the notches. This allows the knob lever N to be pushed in, engaging the feed. If the lever U should not locate properly in the notch in the cam—owing to improper indexing—it would be impossible for the feed to be started, as the knob lever N is securely locked by rod U. The shaft on which the indexing cams are held is provided with notches in which a latch S fits, thus providing a means for bringing the proper cam into position to give the required number of indexings.

The gear cutter G is driven by a belt H which runs on a pulley I held on the top bracket J. This pulley, through a pinion and large bevel gear K, drives a vertical spindle which carries a spur gear, meshing with the gear L attached to the cutter arbor. The feeding of the cutter past the work is accomplished by a worm on the shaft carrying the large bevel gear which meshes with a spur gear located on the shaft M. This shaft, in turn, carries another spur gear that meshes with a larger gear on the screw operating the head carrying the cutter. When knob N is pushed in, it engages a clutch on the end of the feed-screw M thus throwing in the feed. An adjustable washer or dog held on the rod provided with the knob lifts up a finger and thus forces the clutch out of engagement at the end of each cut. This is accomplished by means of a compression spring.

The base O carrying the entire cutter slide mechanism can be swung around and set to any angle within a range of 90 degrees and is locked as indicated. This base is carried on a slide P which can be adjusted back and forth in relation to the work and thus greatly increases the capacity of the machine. The work arbor is held in a slide Q, which is adjustable along the bed by a screw and is locked in the desired position by the wrench shown. The rear shaft is splined so that the worm meshing with dividing wheel E can accommodate itself to the position of the wheel. The bracket carrying the cutter slide can be swung around to different angles, making the latitude of this machine practically unlimited. Bevel gears, spur gears, worm-wheels, etc., can be produced with equal facility, but, of course, not very rapidly. This old Whitworth machine is still in use for cutting worm-wheels having angular teeth—not helical.

The Freeland Gear Cutter

The Freeland gear cutter shown in Fig. 1, when originally built, was designed with the idea of cutting bevel gears, as well as spur gears. This is clearly indicated by referring to Fig. 1, where it can be seen that the cutter slide is held by trunnions to a bracket on the base of the machine. The work arbor remains in a vertical position and for the cutting of various bevel gears the entire head carrying the cutter slide is set over to the desired angle. When converted into an automatic machine, this feature was eliminated and a bracket A as shown in Fig. 2 was provided, being fastened to the cutter slide bracket and also to the bed of the machine. The mechanism which was added to this Freeland machine to convert it into an automatic gear cutter is extremely complicated and also very ingenious. In order to make the following description clear, it probably will be advisable to take up the additions in the sequence in which they were made.

Automatic Return for the Cutter Slide

By referring to Fig. 1 it will be seen that power is transmitted to this machine through a pulley B which, through the spur gears, drives the cutter arbor C. On the shaft directly in line with the pulley is a worm D that meshes with a helical gear on the vertical shaft E. This shaft is connected by spur gears to the feed-screw operating the cutter slide. On the extreme end of shaft F is held a bevel gear, meshing with another bevel gear mounted on the shaft G. This shaft, through spur gears, also connects with the feed-screw operating the cutter slide. The feed-screw carries a double sliding clutch N which is brought into engagement with the upper and lower clutches, and thus provides a means for moving the cutter slide up and down. The downward movement of the cutter slide is accomplished with the top clutch directly under spur gear H, while the lifting of the cutter slide is accomplished with the clutch located directly behind the spur gear I.

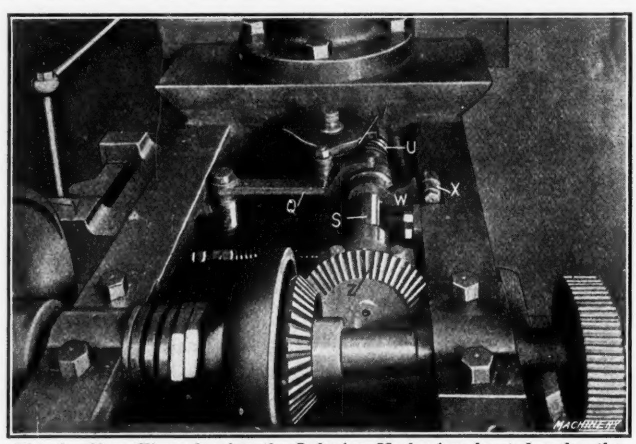

Fig. 4. Close View showing the Indexing Mechanism located under the Table which has been removed

The Automatic Stop

A further development in the Freeland gear cutting machine in connection with the automatic return was the automatic stop or trip. This stopped the downward feeding of the cutter slide and allowed it to be returned. The automatic stop consists of an adjustable dog J which is held in a slot in the cutter slide. This dog is so adjusted that it comes in contact with the lever K when the cutter slide has reached its lowest predetermined position. As the fulcrum lever K on which the rod L is resting is forced out by the adjustable dog, the support is withdrawn from the rod L allowing it to be forced down by a compression spring. Now rod L is pivoted to the yoke lever M, which is fastened to the double sliding clutch N carried on the feed-screw, and as the support is withdrawn from this rod, the sliding clutch is brought into engagement with the lower clutch, which is rotated as previously described to return the cutter slide to its "up" position. As the cutter slide ascends adjustable block T lifts lever M, disengages the clutch, and holds lever M in an intermediate position. At this point in the operation the indexing is accomplished by hand, after which the sliding clutch N is engaged with the upper clutch and the cycle of operations repeated.

The Automatic Indexing Mechanism

The automatic indexing mechanism added to the Freeland gear cutter by William Hall, while having been changed slightly from its original design, still works on practically the same principle as when first completed. As can be seen by referring to Fig. 2, the indexing mechanism is operated by a universal jointed shaft O at the rear of the machine. This is driven from the gear on the feed-screw through a spur gear and clutches P, the lower one being fastened to the top part of the knuckle jointed shaft. On the lower member of the knuckle jointed shaft is held a spur gear meshing with another spur gear on shaft S, see Fig. 4. This view shows the mechanism of the machine, the top guard or table being removed. Shaft S carries a worm U that meshes with a worm-wheel held to the shaft on which the four-lobe cam V is mounted. Shaft S rotates continually—when clutch P is engaged—in the correct relation to the operation of the cutter slide, allowing the required travel of the slide to one-quarter turn of the shaft carrying the cam.

As one of the lobes on this cam comes into contact with the roll on lever Q, it forces the cam W over, bringing it in contact with roller X. This roller, in turn, is connected to the indexing plunger that fits in a notch in the index wheel Y. Now as cam W comes in contact with the roller, it withdraws the indexing plunger and allows the index disk to be rotated through bevel gears Z, and also the dividing wheel M under the machine, see Fig. 3, to be rotated by the change gears A_1, the proportioning of the teeth in which, are such as to give the required space indexing. This indexing mechanism just outlined was that devised by Mr. Hall, and while the idea as arranged was practical, it did not always work successfully and considerable work was spoiled owing to the failure of the locking plunger to engage with the notch in the indexing disk and thus secure the correct indexing.

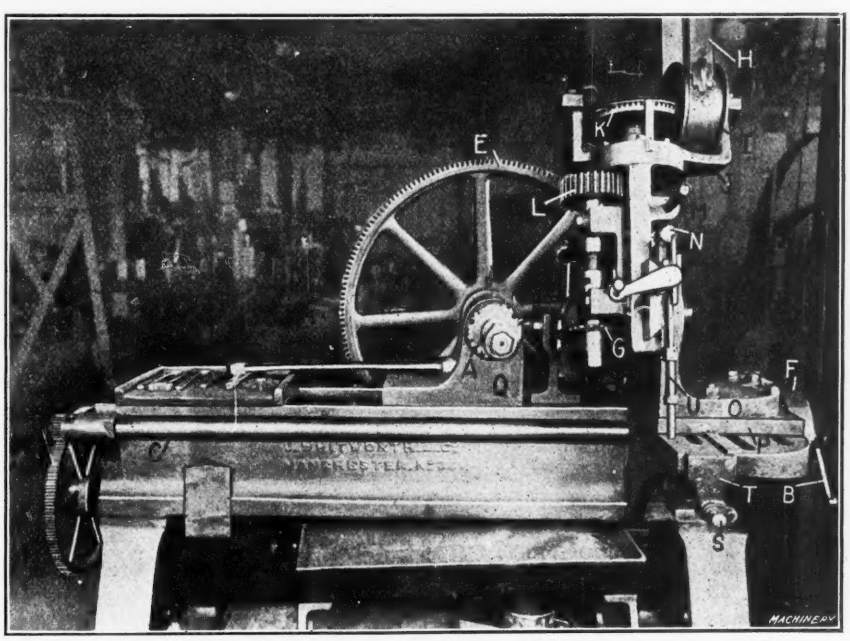

Fig. 5. Gear-cutting Machine built by J. W. Whitworth & Co., Manchester, England This was the First Gear-cutting Machine purchased by R. Hoe & Co.

When the indexing mechanism just described was added, the automatic trip for returning the sliding clutch into engagement with the top clutch to feed the slide down, was also provided. This automatic trip works as follows: When the cutter slide rises and sliding clutch N is brought into an intermediate position by lever M, the link B_1 (see Fig. 2) transmits a movement to lever C_1, bringing the clutch P into engagement, and starts the indexing mechanism operating. The vertical shaft on which clutch P is held carries a worm D_1 which meshes with the spur gear E_1. The shaft carrying this spur gear also holds a cam similar in shape to that shown at V in Fig. 4. This cam guards against improper indexing in the same manner as the device put on the Whitworth machine shown in Fig. 5.

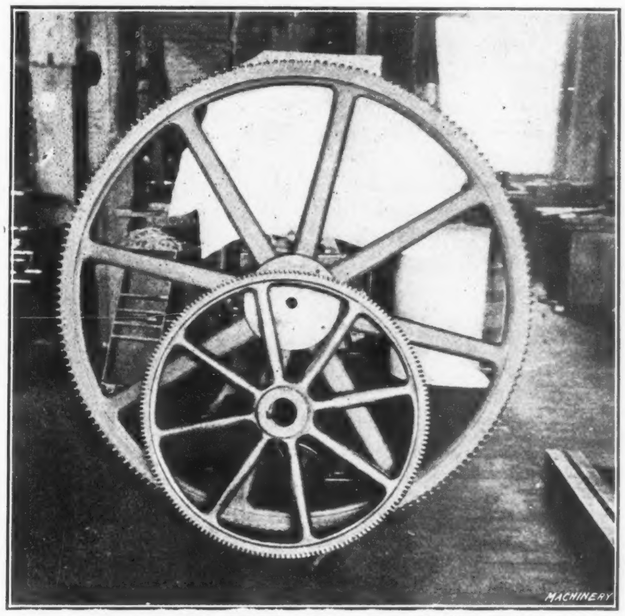

Fig. 6. Master Dividing Wheel and One of the Dividing Wheels reproduced from it on the Whitworth Machine shown in Fig. 5

As the indexing operation nears completion, cam F_1 held on the vertical shaft comes in contact with a bell-crank lever, not shown. This lever lifts a latch supporting lever G_1, allowing the latter to be pulled down by the spring H, and thus disengages clutch P. At this instant the cam at the rear of spur gear E_1 comes into position and raises the lever M, engaging the sliding clutch N with the top clutch to feed the cutter slide down again.

Automatic Safety Device

In order to provide against improper indexing of the work, Joseph Buckley put on a safety device that automatically stops the downward feed of the cutter slide, should the indexing mechanism fail to operate properly. This safety device is indicated in Fig. 1, and consists of a rod I_1 which is held to the slide carrying the indexing locking plunger. This rod through a bell-crank lever operates rod R, which carries a tooth clutch on its upper end. Now when the locking plunger fails to locate properly in the indexing disk, rod I_1 is forced back, transmitting an upward movement to the rod R and engaging the tooth clutch with the gear J_1. Gear J_1 is rotated by a gear held on the feed-screw, when the latter is being operated, and as the clutch is engaged the rod R is revolved. On the lower end of rod R is a one-lobe cam which comes in contact with lever K, forcing it out and withdrawing the support from rod

L— thus disengaging the clutch *N* and stopping the downward movement of the cutter slide. As lever *M* drops, the clutch *N* is held in an intermediate position by the adjustable rod *T*, which comes in contact with the projection on the lever.

The Remodeled Freeland Gear Cutter

In 1883 and 1884 R. Hoe & Co. built six machines patterned after the Freeland machine, improved upon by William Hall and Joseph Buckley. One of these improved machines is shown in Fig. 3, and as can be seen upon reference to it and that shown in Fig. 1, very little change has been made except in a slight remodeling of the automatic safety device, to provide against improper indexing. Six of the seven index wheels cut as previously described were used on these machines, one wheel being kept as a reference wheel. The driving belt is kept in contact with the pulley by means of an adjustable countershaft operated by a weight fastened to wire ropes that run over pulleys attached to a post. These remodeled machines are still doing good work in R. Hoe & Co.'s shops, and while they are not such rapid producers as machines of present-day design, they show to a remarkable extent the ingenuity of those instrumental in their development. As an

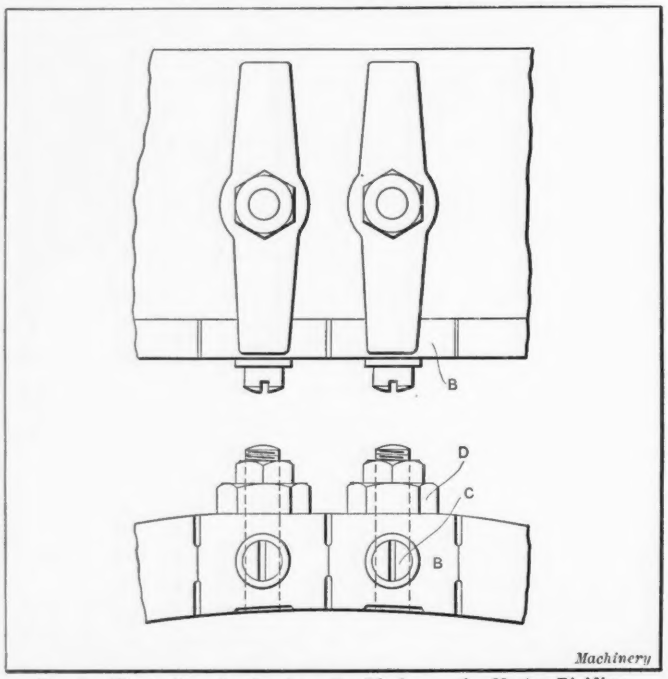

Fig. 7. Illustration showing how the Blocks on the Master Dividing Wheel shown in Fig. 6 were made and held in Place

indication of the desire of this company to keep in step with the progress made in gear cutting, it might be mentioned that the present equipment for this work includes Lees-Bradner hobbing machines, Gleason two-tool bevel gear generators, and Brown & Sharpe automatic gear cutters.

In closing the writer wishes to think Mr. Edwin J. Peirce, production manager, for permission to take the photographs presented, and also Mr. James D. Lamond, tool-room foreman, for the details concerning the interesting development of these automatic gear cutting machines.

* * *

KNURLS FOR KNURLING IN THE LATHE

The knurls commonly used for lathe work have spiral teeth and ordinarily there are three classes known as coarse, medium and fine. The medium pitch is generally used. The teeth of coarse knurls have a spiral angle of 36 degrees and the pitch of the knurled cut (measured parallel to the axis of the work) should be about 8 per inch. For medium knurls, the spiral angle is 29 degrees, 30 minutes and the pitch measured as before, is 12 per inch. For fine knurls, the spiral angle is 25 degrees, 45 minutes, and the pitch, 20 per inch. The knurls should be about 3/4 inch in diameter and 3/8 inch wide; when made to these dimensions, coarse knurls have 34 teeth, medium, 50 teeth, and fine knurls, 80 teeth. To prevent forming a double set of projections when knurling, feed the knurl in with considerable pressure at the start, and then partially relieve the pressure before engaging the power feed. Use oil when knurling.

CUTTING INTERNAL GEAR TEETH ON A VERTICAL SHAPER

An internal gear cutting proposition that would puzzle many machinists is the one illustrated in Fig. 1, which shows a brass casting, approximately five inches internal diameter, within which ninety gear teeth of twenty pitch were required to be cut. This work could easily be handled on a Fellows gear shaper if it were not for the fact that a projecting boss extended into the ring, thus preventing the

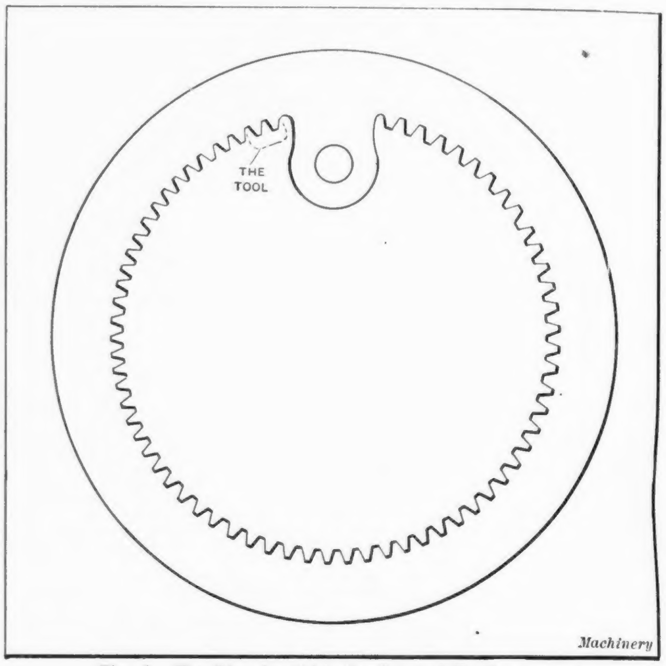

Fig. 1. The Ring in which the Internal Teeth were cut

use of a circular gear cutter. At the Rhodes Mfg. Co.'s shop in Hartford, Conn., where this job was handled, the work was done upon a Rhodes vertical shaper. The shaper with the work on it is illustrated in Fig. 2, from which it will be seen that the casting was mounted upon the circular table with the work centrally located. The tool used was of the shape indicated by the dotted lines extending around

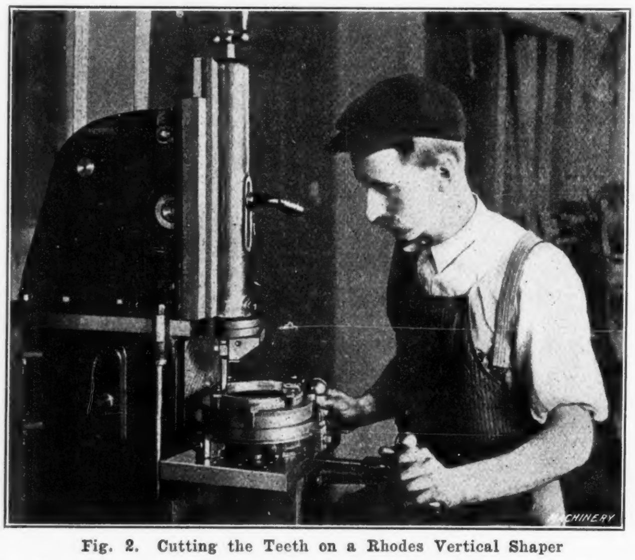

Fig. 2. Cutting the Teeth on a Rhodes Vertical Shaper

the first two teeth at the left of the boss shown in Fig. 1. The tool was first set so as to cut the first two teeth from the boss. The complete depth of cut was not taken with one stroke, but the work was fed out gradually to the tool by means of the hand cross-feed. After the first two teeth were cut the work was withdrawn from the tool, the circular table indexed to the correct pitch and the work fed in again to cut the third tooth. This operation was repeated, finishing one tooth at a time until the entire ninety teeth were finished. The second tooth on the cutting tool acted as a spacer and prevented the tool from springing away. The handling of a job of this kind is quite novel. C. L. L.

STRESS COEFFICIENTS FOR ROOF TRUSSES*

DATA ON THE DESIGN OF ROOF TRUSSES ARRANGED IN CONVENIENT FORM FOR THE DESIGNER

BY CARL E. SCHIRMER†

The current Data Sheet Supplement gives stress coefficients for various types of roof trusses and for different numbers of panels for each type of truss. The term "panel" means one of the spaces into which the upper chord of the truss is divided. In all cases the loading is assumed to be uniform and the stress in any member of a roof truss is obtained by multiplying the panel load by the coefficient for the member in question. These coefficients were obtained by graphical analysis. This method has the double advantage of being rapid and at the same time showing any error which may have been made, as the stress diagram must close if it has been properly drawn.

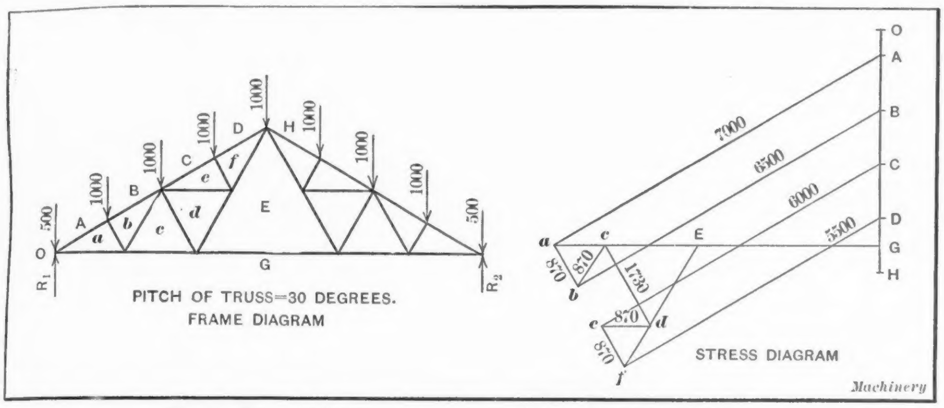

Fig. 1. Frame and Stress Diagrams for Eight-panel Fink Roof Truss

It is not the intention of this article to explain the principles of graphical statics but merely to present data on the design of roof trusses in a convenient form for use by a designer who is not frequently called upon to handle work of this kind. In order to give a brief description of the method by which these Data Sheets were computed, a frame diagram and a stress diagram are presented for three characteristic cases, *i. e.*, for a roof truss uniformly loaded but where the wind load is not considered; for a roof truss uniformly loaded and also carrying a uniform wind load; for the saw-tooth type of roof truss uniformly loaded.

Fig. 1 shows the frame diagram for an eight-panel Fink roof truss in which the distribution of the load is indicated, and also the stress diagram for this truss which is drawn to a scale equal to 1 inch = 1000 pounds. The stress diagram is drawn for one-half the truss, the other half being similar owing to the uniform loading of the truss. The stress diagrams which were drawn to derive the results presented in the Data Sheets, were laid out for the whole truss. The system of notation or lettering is such that any member lies between two letters. Thus *Aa* signifies the top chord member in the first panel on the left-hand end of the truss as shown in Fig. 1.

After drawing the stress diagrams, the results were scaled off and these results were pointed off to three decimal places (divided by 1000), thus obtaining the stress in any member for a panel load of one pound. For example, in the stress diagram shown in Fig. 1, *Aa* represents 7000 pounds for a panel load of 1000 pounds. The stress for a panel load of one pound is therefore 7000 divided by 1000 = 7.000. This value will be found in the table for the eight-panel Fink roof truss in the column for 30 degree pitch. It follows that for any panel load the stress in a given member can be found by multiplying the panel load by the coefficient for that member. The character of the stress (whether tension or compression) will be found in the second column of the Data Sheets. It should be thoroughly understood that in deriving these results, all of the panel loads were regarded as being equal and acting simultaneously.

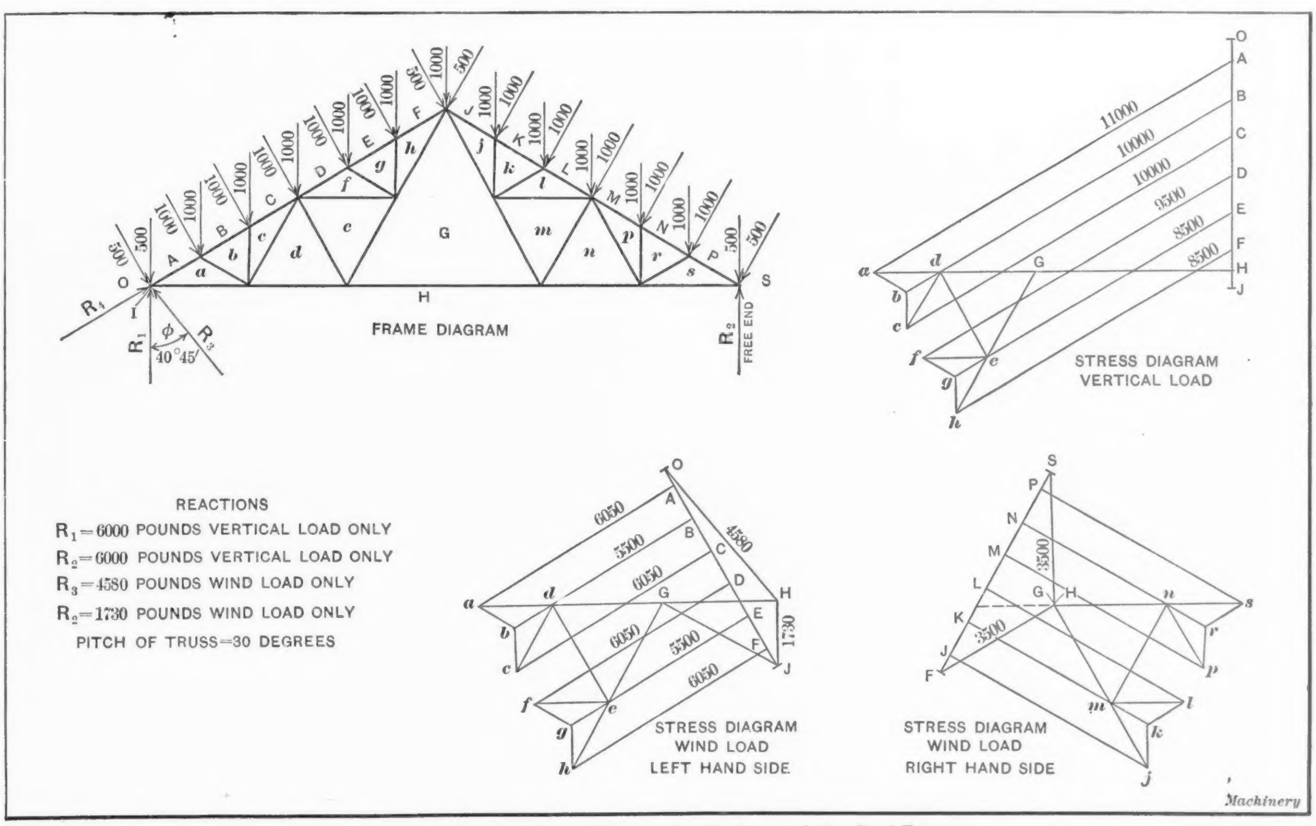

Fig. 2. Frame and Stress Diagrams for Twelve-panel Fan Roof Truss

Fig. 2 shows the frame diagram for a twelve-panel fan type

* With Data Sheet Supplement.
† Address: 1552 Indiana Ave., Toledo, Ohio.

roof truss carrying a uniformly distributed vertical load and a uniform wind load. It should be remembered that all of these loads do not act at the same time, but they are shown in this way in the diagram to save space. The same statement applies to the reactions. R_1 is only for vertical loads; R_2 is of a different amount for the vertical and the wind loads, but is always in the same direction; R_3 is the reaction for the left-hand wind load only; and R_4 is the amount of the fixed-end reaction for the wind load on the free end side of the truss. A typical stress diagram for the vertical load is shown in this illustration, and it will be remembered that the method of constructing such a diagram was discussed in connection with the eight-panel Fink type of roof truss.

Referring to Table I it will be seen that two tables are given —one for the wind load and the other for the vertical load. The results set forth in these tables are for the wind on the left-hand side of the truss which is considered fixed or stationary while the opposite end is considered free. Stress diagrams for the wind load on the fixed end side and on the free end side are also given in Fig. 2. The reaction R_2 for the free end is always vertical, whereas reaction R_3, which is for the wind load on the left-hand side of the truss, is at an angle. The direction of this reaction is determined from the stress diagram for the wind load on the left-hand side of the truss and corresponds to the direction of the line *OH*. The reaction R_3 due to the left-hand wind load is shown by the vertical line *HJ* both in direction and magnitude. The fixed end reaction R_4, due to the right-hand wind load, is given by the line *FH* in the stress diagram for wind load on the right-hand side.

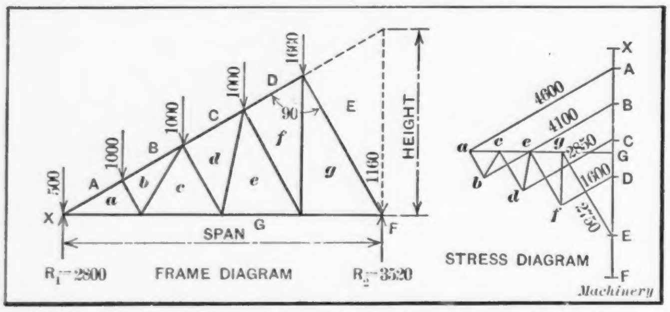

Fig. 3. Frame and Stress Diagrams for Four-panel Sawtooth Roof Truss

By comparing the respective diagrams for the wind loads on the two sides of the truss, it will be seen that the stress in the lower chord members is greater with the wind blowing on the fixed end or left-hand side. With the wind load on the fixed end, the members *Gj*, *Gm*, *jk*, *kl*, *lm*, *mn*, *np*, *pr*, and *rs* are not subjected to stress and consequently take no part in carrying the load—that is theoretically. The same members on the opposite side of the truss and in the same relative position, are inactive when the wind acts upon the right-hand or free end. The members *Gh*, *dH* and *aH* are likewise found to be without stress as far as right-hand wind load is concerned. As the truss must be proportioned for the maximum stresses and as the stresses due to wind load are greater with the wind acting upon the fixed end (in this case the left-hand end) the coefficients given in the Data Sheets are for the maximum stress. Many engineers assume an equivalent vertical load to take care of the wind load and add such a load to the loads due to the weight of the roof, to snow on the roof and to the weight of the truss itself.

In explaining the design of trusses for the sawtooth type of roof, the four-panel, 30-degree truss is taken as an example. Fig. 3 shows the frame diagram for this truss, in which it will be seen that uniform loading is assumed. The panels *A*, *B*, *C* and *D* are equal; hence the loads at *AB*, *BC* and *CD* represent the load carried by one panel, *i. e.*, 1000 pounds. The load *XA* at the left-hand end is equal to one-half of the panel load. It will be seen that the panel *E* is longer than the other panels and hence it carries a larger load; the load *DE* was assumed to be made up of one-half the panels *D* and *E* which amounts to 1660 pounds. The load *EF* at the right-hand end of the truss is equal to one-half the panel load *E* cr 1160 pounds. It should be noted that the coefficients given for these loads are 1.66 and 1.16 respectively, from which it will be seen that with a given load at *AB*, *BC* or *CD*, which are equal, the load at *DE* or *EF* can be easily obtained by multiplying their respective coefficients by that load.

The height of the truss is taken as the vertical distance from the bottom chord to a projection of the top chord and the member *gE* makes an angle of 90 degrees with the top chord. The reactions are calculated by the method of moments. The left-hand reaction R_1 is 2800 pounds, and the right-hand reaction R_2 is 3520 pounds. It will be well to note that the coefficients given in the Data Sheet are 2.8 for R_1 and 3.52 for R_2. Multiplying these factors by the load at either *AB*, *BC* or *CD*, gives the respective reactions.

A stress diagram for this type of roof truss is illustrated in Fig. 3. Referring to the Data Sheet it will be seen that the stress coefficient for the member *Aa* in the 30-degree pitch column is 4.60. Multiplying the load at *AB*, which is 1000 pounds in this case, by this factor gives a stress of 4600 pounds, the member being under compression. The angle θ is the inclination of the top chord to the bottom chord.

In all types of roof trusses, except the sawtooth, the pitch is obtained from the following formula:

$$\text{Pitch} = \frac{\text{height}}{\text{span}}$$

In the case of the sawtooth type of roof truss the pitch is as follows:

$$\text{Pitch} = \frac{\text{height}}{2 \times \text{span}}$$

Therefore, the height of the truss is obtained by multiplying the pitch by the span or by twice the span, according to the type of truss under consideration. The height can be readily found by means of the preceding formulas for pitches of 1/3, ¼, and 1/5 but for the 30-degree pitch this is not the case. To find the height of a 30-degree pitch truss, the following formula is used:

$$\text{Height} = \frac{\text{span}}{2} \times \tan 30 \text{ degrees.}$$

The use of this Data Sheet Supplement should prove of particular value in starting upon the design of a new building when it is desirable to compare the relative economy of several different types of roof trusses.

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DRILLING HOLES IN GLASS

There are several methods of drilling holes in glass. For holes of medium and large size, use brass or copper tubing, having an outside diameter equal to the size of hole required. Revolve the tube at a peripheral speed of about 100 feet per minute, and use carborundum (80 to 100 grit) and light machine oil between the end of the pipe and the glass. Insert the abrasive under the drill with a thin piece of soft wood to avoid scratching the glass. The glass should be supported by a felt or rubber cushion, not much larger than the hole to be drilled. If practicable, it is well to drill about half way through and then turn the glass over and drill down to meet the first cut. Any fin that may be left in the hole can be removed readily with a round second-cut file wet with turpentine. For comparatively small holes, a solid drill is often used. Use steel rod or an old three-cornered file, grinding the end to a long tapering triangular shaped point. Grip the drill in a chuck and rotate rapidly. Use a mixture of turpentine and camphor as a lubricant. Holes up to about ½ inch diameter can readily be drilled in glass with a flat drill which has been hardened in sulphurous acid, a mixture of turpentine and camphor being used as a lubricant.

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The year 1912 was a record one as respects German export and import trade. During that year, the value of the exports amounted to about $2,250,000,000 and the imports to about $2,675,000,000, so that the sum total of imports and exports came close to five billions. In many other respects, 1912 was a record year in German industries. The tonnage of merchant vessels constructed in German shipbuilding yards was over 375,000 tons, an increase of nearly 50 per cent over that in 1911. In the export trade, the United Kingdom was the greatest customer of Germany.

THE HOLLERITH TABULATING MACHINE IN THE BUSINESS OFFICE

A RAPID MEANS OF COMPILING AND TABULATING STATISTICS

BY S. G. KOON*

Statistics essential to the intelligent consideration of every manufacturing or selling proposition must be compiled quickly and tabulated promptly if they are to be of value. Information of value today is often valueless next week.

The president of a large steel company called suddenly for an analysis of the sales for the preceding five years. The next morning he had the complete analysis for the three most recent years. But as it would have taken a whole month, with a considerable increase in the accounting force, to give him the other two years, he accepted the three years then instead of five years a month later. The reason for this is simple. Hollerith tabulating machines and cards had been used for three years; prior to that reports were all in loose-leaf form, and the work of compiling the special report would have involved going to original sources and working over every piece of information from start to finish. By the Hollerith system, punched cards are used which sort, classify, and aggregate the amounts recorded, in any manner desired and practically automatically. This method of transferring records to cards, and

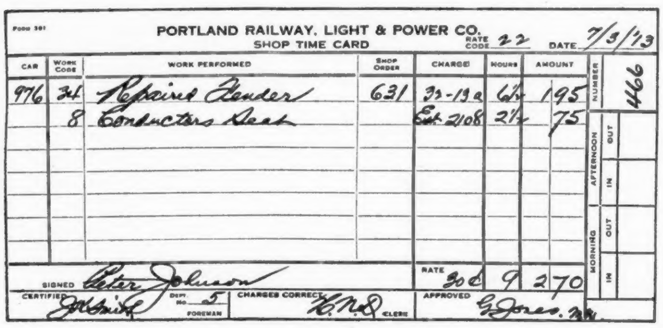

Fig. 1. Time Card for Two Operations from which Statistical Cards are punched

then analyzing the records, is capable of positive proof for correctness. It gives results which are available for reports immediately after closing business daily, weekly or monthly, as required. Figures may be obtained by this means within a few hours, where formerly weeks were needed. They may be obtained in much greater detail and at an expense far less than that of getting such complete results in any other way.

The system is used in factories of all sorts, in steel mills, by insurance companies, by electric light and traction and telephone companies, by wholesale merchandise establishments and department stores, by textile mills, automobile companies, numerous railroads, municipalities and state governments. It is used for compiling labor costs, efficiency records, distribution of sales, internal requisitions for supplies and materials,

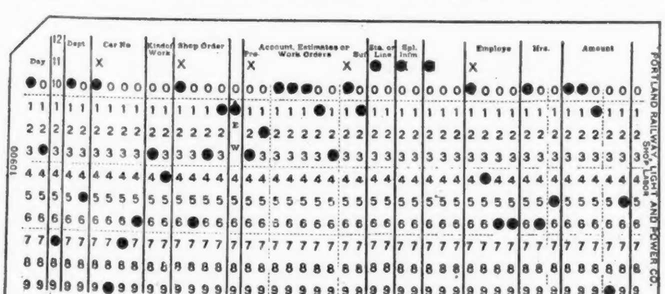

Fig. 2. Statistical Card punched for First Operation on Time Card

production statistics, day and piece work. It is used for analyzing risks in life, fire and casualty insurance, for plant expenditures and sales of service, by public service corporations, for distributing sales and cost figures as to salesman, department, customer, location, commodity, method of sale, and in numerous other ways. The cards, besides furnishing the basis for regular current reports, provide also for all special reports and make it possible to obtain them in a mere fraction of the time otherwise required.

The analyses and reports are obtained by means of cards, punched according to a code representing certain fundamental facts, and then run through two automatic machines. These first assort the cards according to a predetermined arrangement; then having obtained the grouping desired, they record details and totals on counters from which they are taken off to blanks suitably prepared. Electric contacts, made when a

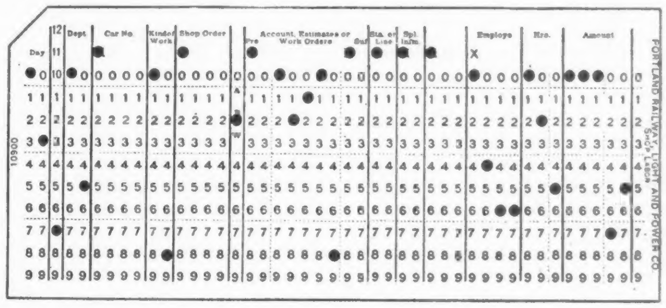

Fig. 3. Statistical Card punched for Second Operation on Time Card

punched hole in the card passes over a brush terminal in the apparatus, produce the action of either machine in so certain and positive a manner that far fewer errors are made than by any method of hand analysis. The cards can be grouped to give any possible result, and can be resorted and tabulated any number of times. The ability of these machines to handle this sort of analysis satisfactorily lies in their power to count combined facts. Each counter adds a different set of figures.

One machine tool builder uses this system for compiling costs, analyzing payroll, sales and shipments, keeping track of materials, and hence, compiling a perpetual inventory. The possibilities of its use are said to be almost untold. An electric service company, by adjusting the sorting machines to sort cards by car numbers, obtains the aggregate shop cost in

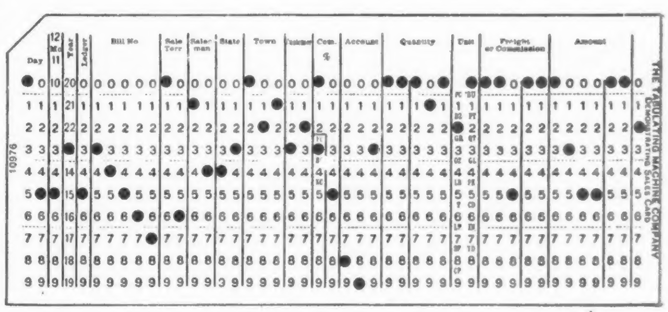

Fig. 4. Another Statistical Card punched from a Different Set of Specifications

labor and material during any given time and for each car automatically and quickly. Fig. 1 shows a shop time card made out for two operations, and Figs. 2 and 3 show the statistical cards punched from this record at the end of the week or month for distributing costs, etc. Following through the punching of the card in Fig. 2 from the information given on the time card for the first operation, Fig. 1, it will be seen that the day has been punched as 3, the month as 7, the department as 5, the car number as 976, kind of work as 34 (work code), shop order as 631, work order as 32-13, the employe as 466, hours as 6.5 and amount as 195 ($1.95). In the same way information for the second operation is punched on the card shown in Fig. 3. Fig. 4 shows a card punched from a different set of specifications. If the cost of any special kind of work, such as winding field coils, is desired, this can be obtained in the same way by running the cards through the machine again after setting it to catch and record that item. Set in still another way, the time spent by any employe upon any particular class of work or upon all kinds of work can be obtained.

The auditor of the Board of Education of New York City recently prepared his budget, covering an expenditure for 1913 of forty million dollars, from Hollerith cards which had been punched as a record of previous disbursements. One of the

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transcontinental railroads finds it necessary to refer repeatedly to traffic statistics in connection with rate litigation and kindred subjects. The volume of traffic is such that complete reports could not be obtained without enormous cost in both time and money, except for the fact that all traffic statistics are analyzed regularly by means of the tabulating system. This road estimates that present results in routine work without the aid of the machines would cost from 50 to 75 per cent more than at present.

In any shop, by punching cards direct from employes' time tickets, payrolls can be made up quickly and shop costs compiled easily, which must agree absolutely with the payrolls. From these cards, job costs to the finest detail can be figured promptly, and comparisons of men and work made. For every classification, whether part of the current analysis or of a subsequent special report, one and the same batch of cards is used over and over again, without any recopying of original entries. There is thus no possibility of repeated errors or transposition of figures; nor can any figure be used twice.


Fig. 5. Southern Pacific R. R. Co., San Francisco. Twelve tabulating machines are required to perform the traffic and other analyses on this railway system

The cards are made in two sizes, each with two widths of column spacing. As the location of the column on the card determines the location of the column in the counter upon which the result is finally recorded, the machines are necessarily arranged to fit the card adopted. The long or full sized card will accommodate 37 wide-spaced or 45 narrow-spaced columns; the smaller card will take 27 or 34 columns. In the actual application to the card it is not simply a question of the notation of numbers and figures on the card, but of the indication of those symbols by means of perforations at measured distances from the top, bottom and ends of the card. The key punch used to perforate the cards accords with the card dimensions and the column spacing. It may be considered the writing instrument. The rate of punching varies materially with the amount of information carried. It is more rapid than ordinary card writing or the usual speed of journalizers or entry clerks. Depending upon the number of holes punched, cards are prepared by seasoned operators at the rate of 1500 to 4000 per day, the average output being not far from 2500. Many items are repeated from one card to the next. This is particularly true of dates, departments, classes of transaction, origin of business, etc. To avoid punching these individually, a gang punch is used for multiple punching. This will punch a dozen or fifteen cards at once and covers nine or ten items on each card.


Fig. 6. Southern Pacific R. R. Co.'s Card Punching Department. The extent of the use of this system by a railroad is indicated by the number of girls employed in punching cards

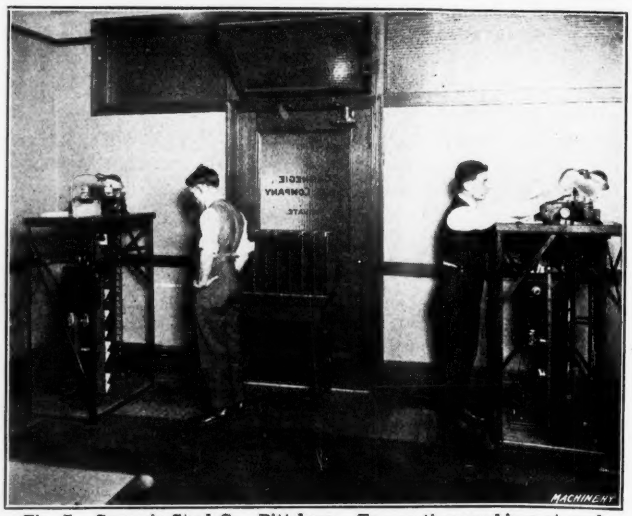
Fig. 7. Carnegie Steel Co., Pittsburg. Two sorting machines at work sorting cards at the rate of 250 per minute each

In nearly all cases, mechanical sorting is necessary before the cards can be used in the tabulator to obtain the required analysis. The sorting machine is used for the arrangement and rearrangement of the cards into orderly groups, such as by states, by agencies, by style of job or color of the product under analysis. The cards are sorted at a speed of about 250 per minute into pockets or boxes in the machine, each corresponding to one row on the cards. This is done for a single column at a time. Owing to the necessity of handling the cards, this rate of speed is cut down markedly in a day's run.

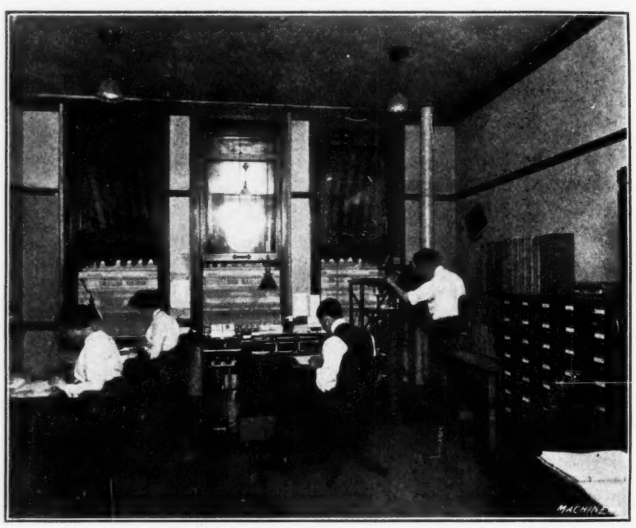
Fig. 8. Cleveland Electric Illuminating Co. A complete statistical unit —two key punches at left, sorting machine in corner, tabulator in center, and gang punch at right in front of card cabinet

When the sorting has once been done, the cards are run through for tabulation, obtaining such totals as are necessary. If any further sorting is required the same set of cards which has been run through the tabulator is again put into the sorting machine, resorted in accordance with some other classification, and again run through the tabulator. The tabulator carries from two to five counters, each having from one to seven magnets. Each counter may therefore add numbers with from one to seven digits.

The tabulating machine, electrically controlled and mechanically operated, adds the numerical amounts up to a maximum of thirty-five columns at a time. The operating speed is 150 cards per minute. In the five-counter machine, 750 individual items may be added in one minute.

COLORING NON-FERROUS METALS AND ALLOYS*

CLEANING WORK—RECEIPTS FOR PRODUCING DIFFERENT COLORS—OXIDIZING—MOTTLING

BY E. F. LAKE†

Man is so much a product of nature that mere light and shade, or white and black, are only pleasing for a time. To fully satisfy his natural desires, man's vision must be stimulated by views of different colors and various combinations thereof. To look upon one color continuously is one of the most tiresome things he can do, as it affects his entire nervous system. This has led to the coloring of metals, and to producing many beautiful effects in place of the natural color of the metal which may become repulsive from being seen too frequently.

In thickly inhabited sections a great deal of coal gas is burned. More or less of the products of combustion together with the gases arising from the manufacture of other materials stay in the atmosphere and give to brass and bronze objects a dark, dirty color by attacking their surfaces. The oxygen and moisture in the atmosphere also give these metals or alloys a disagreeable color. Hence coloring or coating is also resorted to for the purpose of enhancing and preserving the original beauty of the metal. Sometimes rich and beautiful browns and greens are produced on copper alloys that have been subjected to atmospheric conditions for years. Therefore these conditions have been studied and chemical means have been found for producing the colors quickly and on a commercial scale.

Copper is more susceptible to coloring processes and materials than any of the other metals, and hence the alloys containing large percentages of copper are readily given various shades of the yellow, brown, red, blue and purple colors and also black. Alloys with smaller percentages of copper, or none at all, can be given various colors, but not as easily as if copper were the principal ingredient, and the higher the copper content, the more readily can the alloy be colored. The shades, and even the colors, can be altered by varying the density of the solution, its temperature and the length of time the object is immersed. They can also be altered by finishing the work in different ways. If a cotton buff is used one shade will be produced; a scratch brush will produce another, etc. Thus to color work the same shade as that of a former lot all the data in connection with these operations must be preserved so they can be repeated with exactness.

Many different kinds of salts are made into solutions for the coloring processes. When capable of producing the desired results it is always best to use the simple salts. It is often necessary to combine two or more salts in the solution to get the required color, but these deteriorate in strength much more rapidly than the simple salt solutions and hence the last piece immersed will have a lighter color than the first one. When adding salts to bring back the original strength of the bath, they should first be dissolved in a small amount of water to prevent their settling to the bottom where they might become covered with an insoluble mud that would prevent them from being dissolved. In making the solutions it should be remembered that a strong solution will produce the color quickly and a weak solution more slowly. When a uniform coating can be produced the strong solution is always the best owing to the time factor. The most effective and lasting results, however, are obtained with the weaker solutions, and hence they are used for high-grade work. While these solutions are often used cold, there are many cases where better results can be obtained when they are heated. Raising the bath to the boiling point will insure a complete solubility of the salt.

Cleaning Work to be Colored

Cleaning the work is of the utmost importance before attempting to give it any kind of color. A greenish or brownish film forms on copper, brass, bronze, etc., when they stand, as they are attacked by the moisture in the air and the simultaneous presence of carbonic acid which gradually changes into carbonates. This film is a mixture of carbonate of copper and oxide. Often sulphur compounds are formed when the atmosphere is impregnated with the products of combustion arising from the coal gas burned in cities and towns. This is nearly always stronger in rooms than in the open. If these films are not removed before coloring they show up as stains and the work will be streaked or spotted. Touching the work with the bare hands after it is cleaned will also leave a slight film that will make the work spotted, and hence it should be strung on wires or handled in other ways that will prevent it from being touched with the hands.

Several acid dips can be made that will remove these films and leave the bright clean metal with its original smooth surface. Work that will stand heating can be heated to a dull red and then plunged into dilute sulphuric acid, after which it should be soaked in old aquafortis and then thoroughly rinsed. It should be soaked long enough to have a uniform metallic appearance, and the bath should be large enough in volume to prevent its heating up from the hot work. The best results are obtained with straw-colored aquafortis, as the white is too weak and the red too strong. In diluting the sulphuric acid it should always be poured into the water slowly, as heat is generated, and too rapid mixing generates so much heat that the containing vessel is liable to crack and the escaping liquid to cause burns. To pour water into sulphuric acid will cause an explosion that is almost sure to result in serious, if not fatal, burns from the flying liquid.

A good method of removing these films, without heat, is to soak the work in a pickle composed of spent aquafortis until a black scale is formed and then dip it for a few minutes into a solution composed of 64 parts water, 64 parts commercial sulphuric acid, 32 parts aquafortis and 1 part hydrochloric acid. After that the work should be thoroughly rinsed several times with distilled water. If the strong aquafortis is used for the pickle in which the work is soaked it will cause a too rapid corrosion of the copper during the time of the solution of the protoxide. Hence the spent aquafortis is better on account of its slower action and it also saves the cost of new. A dip that is useful for removing the sand, etc., that sticks to castings is composed of 1 part spent aquafortis, 2 parts water and 6 parts hydrochloric acid. A few minutes will suffice for small pieces, but large castings can remain in the bath for thirty minutes. They become coated with a black mud and when this is thoroughly washed off they should be bright.

If a further whitening of the work is desired a solution may be made by mixing 3 pounds nitric acid, 4 pounds sulphuric acid and 40 grains sodium chloride (table salt), combining this with 40 times its bulk of water and allowing it to cool before using. If a dead surface is desired the following mixture can be added to the bath: 2 pounds nitric acid, 1 pound sulphuric acid, 10 grains sodium chloride and 40 grains zinc sulphate. The degree of deadness is determined by the length of time the work is left in the bath. As with all other solutions, the work should be well rinsed after leaving the bath and then thoroughly dried. Another dead dipping bath can be made from one part of a concentrated solution of potassium bichromate and two parts of concentrated hydrochloric acid. Many other combinations of chemicals may also be made for cleaning or whitening the work or giving a dead finish after it has been colored, but those given above will suffice for the present.

Bright Castings

The bright clean color sometimes seen on bronze castings has been thought by many to be the result of an acid dip. This has been produced, however, by plunging the castings into water while they are still red-hot. It is seldom that brass castings can be given this color as they usually contain too much lead. Likewise the bronze castings must be free

* For previous articles published in MACHINERY on coloring metals see "Coloring Iron and Steel Products," June, 1913, and other articles there referred to.

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from lead as well as iron, antimony or other impurities, and the water into which they are plunged must be clean, or a dirty, unpleasant color will be the result. The castings must also be as hot as possible when quenched. If too hot the metal will be brittle and hence the highness of the temperature is governed by the toughness that is desired in the casting, but if quenched after they have cooled too much the color will be dull. Copper ingots can be given a beautiful rose-red color by this method.

To Produce Yellow to Orange Colors

From a golden yellow to orange color can be given polished brass pieces by immersing them for the correct length of time in a solution composed of 5 parts caustic soda to 50 parts water, by weight, and 10 parts copper carbonate. When the desired shade is reached the work must be well washed with water and dried in sawdust. Golden yellow may be produced with the following: Dissolve 100 grains lead acetate in 1 pint water and add a solution of sodium hydrate until the precipitate which first forms is redissolved, and then add 300 grains red potassium ferricyanide. With the solution at ordinary temperatures the work will assume a golden yellow, but heating the solution darkens the color until at 125 degrees F. it has changed to a brown. A pale copper color can be given brass by heating it over a charcoal fire, with no smoke, until it turns a blackish brown, then immersing in a solution of zinc chloride that is gently boiling, and finally washing thoroughly in water. Dark yellow can be obtained by immersing for five minutes in a saturated solution of common salt containing some free hydrochloric acid and which has as much ammonium sulphide added as the solution will dissolve.

To Produce a Rich Gold Color

A rich gold color can be given brass by boiling it in a solution composed of 2 parts saltpeter, 1 part common salt, 1 part alum, 24 parts water, by weight, and 1 part hydrochloric acid. Another method is to apply to the work a mixture of 3 parts alum, 6 parts saltpeter, 3 parts sulphate of zinc and 3 parts common salt. The work is then heated over a hot plate until it becomes black and then washed with water, rubbed with vinegar and again washed and dried. Still another solution is made by dissolving 150 grains sodium thiosulphate in 300 grains water and adding 100 grains of an antimony chloride solution. After boiling for some time the red-colored precipitate must be filtered off, well washed with water and added to 4 pints of hot water. Then add a saturated solution of sodium hydrate and heat until the precipitate is dissolved. Immerse the brass articles in the latter solution until they have attained the correct shade. If left in too long they will be given a gray color.

To Produce White Colors or Coatings

The white color or coating that is given to such brass articles as pins, hooks and eyes, buttons, etc., can be produced by dipping them in a solution that is made up as follows: Dissolve 2 ounces fine grain silver in nitric acid, then add 1 gallon distilled water and put into a strong solution of sodium chloride. The silver will precipitate in the form of chloride and this must be washed until all traces of acid are removed. Testing the last rinse water with litmus paper will show when the acid has disappeared. Then mix this chloride of silver with an equal amount of potassium bitartrate (cream of tartar) and add enough water to give it the consistency of cream. The work is then immersed in this and stirred around until properly coated, after which it is rinsed in hot water and dried in sawdust.

Silvering

Another method of silvering that is applicable to such work as gage or clock dials, etc., consists of grinding together in a mortar 1 ounce very dry chloride of silver, 2 ounces cream of tartar and 3 ounces common salt. Then add enough water to make it of the desired consistency and rub it on the work with a soft cloth. This will give brass or bronze surfaces a dead white thin silver coating, but it will tarnish and wear if not given a coat of lacquer. The ordinary silver lacquers that can be applied cold are the best. Before adding the water, the mixture as it leaves the mortar can be kept a long time if put in very dark colored bottles, but if left where it will be attacked by light it will decompose.

Assorted Colors

Some very interesting results in coloring brass can be obtained by dissolving 200 grains sodium thiosulphate and 200 grains lead acetate in 1 pint water and heating it to from 190 to 195 degrees F. Immersing the work in this for five seconds will make it pale gold; fifteen seconds, brown gold; twenty-five seconds, crimson; thirty seconds, purple; forty-five seconds, an iridescent bluish crimson green; sixty seconds, pale blue; sixty-five seconds, mottled purple; eighty seconds, nickel color; eighty-five seconds, mottled blue and pink; one hundred and ten seconds, mottled purple and yellow; two and one-half minutes, pale purple; four minutes, mottled pink and yellow; five minutes, mottled pink and gray; ten minutes, mottled pink and light blue. Other combinations of colors can also be obtained, but some of these fade and change color unless protected by a coat of lacquer. By using one-quarter ounce of sulphuric acid in place of the lead acetate a variety of colors can also be produced, but they will not be as good a quality as those made with the above solution. Nitrate of iron can be used with equally good results.

To Produce Gray Colors

A solution of 1 ounce of arsenic chloride in 1 pint of water will produce a gray color on brass, but if the work is left in too long it will become black. The brass objects are left in the bath until they have assumed the correct shade and then are washed in clean warm water, dried in sawdust and finally in warm air. A dark gray color that can be made lighter by scratch brushing can be obtained by immersing the work in the following solution: 2 ounces white arsenic oxide, 4 ounces commercially pure (c. p) hydrochloric acid, 1 ounce sulphuric acid and 24 ounces water. A steel gray can be produced with the following: 20 ounces arsenious oxide, 10 ounces powdered copper sulphate, 2 ounces ammonium chloride and 1 gallon common hydrochloric acid. After mixing, this should stand for one day. A 5 per cent solution of platinum chloride in 95 per cent water will also produce a dark gray color if it is painted on and the brass is warmed. Weaker solutions will make the color lighter. Copper can also be colored, but the platinum does not adhere as firmly to the surface as it does on brass. A coating of lacquer is required to make it permanent. By smearing the work with a mixture of 1 part copper sulphate and 1 part zinc chloride in 2 parts water and drying this mixture on the brass, with heat, a dark brownish color is obtained. If desirous of immersing the work a weaker solution could be used. The color is changed very little by exposure to light.

To Produce Lilac Blue and Violet Colors

The lilac shades can be produced on yellow brass by immersing the work in the following solution when heated to between 160 and 180 degrees F. Thoroughly mix 1 ounce chloride, or butter, of antimony in 2 quarts muriatic acid, and then add 1 gallon water.

To give brass a blue color dissolve 1 ounce antimony chloride in 20 ounces water, and add 3 ounces hydrochloric acid. Then warm the work and immerse it in this solution until the desired blue is obtained. After that, wash it in clean water and dry in sawdust. A permanent and beautiful blue-black can be obtained by using just enough water to dissolve 2 ounces copper sulphate and then adding enough ammonia to neutralize and make it slightly alkaline. The work must be heated before immersion. Copper nitrate, water and ammonia will also yield this rich blue-black, but if the brass is very highly heated after immersion it changes to a dull steely black. On copper or work that is copper-plated this latter produces a crimson color.

A beautiful violet color can be produced on polished brass with a mixture of two solutions. First, 4 ounces sodium hyposulphite is dissolved in 1 quart water, then 1 ounce sugar of lead is dissolved in another quart of water and the two are well stirred together. By heating this to 175 degrees F. and immersing the work the correct length of time, it takes on the violet color. The work first turns a golden yellow and this

gradually turns to violet. If left a longer time the violet will turn to blue and then to green. Thus this same preparation can be used for all of these colors by correctly limiting the time that the work is immersed.

To Produce Green Colors

When left to the natural action of the atmosphere, or ageing, most of the brasses and bronzes first turn green, and very decidedly so if near the ocean where the moisture from the salt water attacks the metal. This green color gradually darkens and then turns brown and finally black. Some of the shades it assumes are very beautiful and hence they have been produced by chemical means, as nature is too slow in its action. So many different chemical combinations are used for this purpose that it would require a book to enumerate them all and hence only a few can be mentioned. Some of the green colors can be produced by the solutions given above, but the antique, or rust, greens require different mixtures.

One solution that will produce the verde antique, or rust green, is composed of 3 ounces crystallized chloride of iron, 1 pound ammonium chloride, 8 ounces verdigris, 10 ounces common salt, 4 ounces potassium bitartrate and 1 gallon water. If the objects to be colored are large, this can be put on with a brush and several applications may be required to give the desired depth of color. Small work should be immersed and the length of time it is immersed will govern the lightness or darkness of the color. After immersion, stippling the surface with a soft round brush, dampened with the solution, will give it the variegated appearance of the naturally aged brass or bronze. Another solution that will give practically the same results is composed of 2 ounces ammonium chloride, 2 ounces common salt, 4 ounces aqua-ammonia and 1 gallon water. The work may have to be immersed or painted several times to give it the desired coating, and after washing and drying it should be lacquered or waxed. The Flemish finish can be given brass with a solution composed of ¼ ounce sulphuret of potassium, 1 to 2 ounces white arsenic, 1 quart muriatic acid and 10 gallons of water. The arsenic should be dissolved in a part of the acid by heating and then mixed with the balance of the acid and water. Two ounces sulphuret of potassium in a gallon of water may also be used if it is heated to 160 degrees F. One ounce sulphuric or muriatic acid in a gallon of water darkens the color produced by this last mixture.

To Produce Brown Colors

Many different shades of brown can be produced and many different chemicals are used to form solutions or pastes for this purpose. In these liver of sulphur, either potassium sulphide or sodium sulphide, is one of the most commonly used chemicals. One-fourth ounce liver of sulphur in 1 gallon water will give bronze a brown color when used cold but if heated it is more effective. The depth of the color is governed by the length of time that the work is immersed. If left in too long, however, it becomes black and if too much liver of sulphur is used the color will be black. Copper is turned black even with the weak solutions. To set the color it should afterwards be immersed in water containing a small amount of sulphuric or nitric acid. Brass is not attacked by this solution but if caustic potash is added it causes the liver of sulphur to color the brass. Then 2 ounces liver of sulphur should be added to 1 gallon water and from 2 to 8 ounces caustic potash, according to the shade of brown that is desired; the more potash the darker will be the color. A solution composed of ½ ounce potassium sulphide in 1 gallon of water will produce a gray or greenish color on brass when cold but when heated to 100 degrees F. it produces a light brown; at 120 degrees, a reddish brown; at 140 degrees, a dark brown; and at 180 degrees, a black color.

The barbedienne bronze, or brown, color can be produced on cast brass or bronze by immersing in a solution made by dissolving 2 ounces golden sulphuret of antimony and 8 ounces caustic soda in 1 gallon water. The work must be properly cleaned beforehand and afterwards scratch-brushed wet, with a little pumice stone applied when brushing. It must then be well washed and dried in sawdust. A second immersion in a solution of one-half the above strength will have a toning effect, and the work must again be washed and dried. The high light can be made to show relief by rubbing the object with pumice stone paste on a soft rag. A dead effect can be produced by immersing in a hot sulphuret of antimony solution for ten or fifteen seconds, then rewashing and immersing in hot water for a few seconds and drying in sawdust. The work should be lacquered to preserve the tones and waxed when the lacquer has become dry and hard. This brown color can be darkened by a five-seconds immersion in a cold solution of 8 ounces sulphate of copper in 1 gallon water. Some other processes use two solutions, the first of which is heated and the second used cold, after which the work is rinsed in boiling water.

To Produce Black

There are as many different processes and solutions for blackening brass as there are for browning, and consequently only a few can be given. Trioxide of arsenic, white arsenic or arsenious acid are different names for the chemical that is most commonly used. Its use can be traced back to the fifth century and it is the cheapest chemical for producing black on brass, copper, nickel, German silver, etc. It has a tendency to fade and a much greater tendency if not properly applied, but a coat of lacquer will preserve it a long time. A good black can be produced by immersing work in a solution composed of 2 ounces white arsenic and 5 ounces cyanide of potassium in 1 gallon water. This should be boiled on a gas stove, in an enamel or agate vessel and used hot. Another cheap solution is composed of 8 ounces sugar of lead, 8 ounces hyposulphite of soda and 1 gallon water. This must also be used hot and the work afterwards lacquered to prevent fading. When immersed the brass first turns yellow, then blue and then black, the latter being a deposit of sulphide of lead.

The ammonia-copper carbonate solution much used for medals, ornaments, etc., is made by taking the desired quantity of the strongest ammonia water and mixing it with an equal amount of distilled water, and dissolving carbonate of copper in it until it is thoroughly saturated and a little remains undissolved. This is placed in a stone crock and surrounded with water and then heated to from 150 to 170 degrees F. before the work is immersed. After immersing for a few seconds the brass will turn black and it is then removed and first rinsed in cold water and dried and then given a coat of dead, black lacquer.

A black that will withstand the wear of such articles as desk telephones can be given to brass with a solution that is made as follows: Mix 1 ounce nitrate of copper with 1 ounce water. Then mix 1 ounce nitrate of silver with 1 ounce water. Then combine 1 part of the nitrate of silver solution with 2 parts of the nitrate of copper solution and 3 parts water. Heat the brass, bronze or copper article to 250 degrees F., and give it two coats of this solution with set-in-rubber brushes. When the fluffy smut is brushed off with a stiff bristle brush, the work will be found to have a pleasing brownish black color that is tenacious. If it is desired to change this to a dead black the article can be immersed for 5 minutes in a cold solution made from 2 ounces liver of sulphur in 1 gallon water. It is then removed and heated until uniformly dead black and again brushed. It can then be given a coat of flat lacquer or waxed.

Oxidizing

Solutions that produce the green, brown or black colors are usually used when it is desired to oxidize copper, brass or bronze. A dark slate green can be produced with a solution composed of 8 ounces double nickel salts, 8 ounces sodium hyposulphite and 1 gallon water. The color is almost instantly produced when the temperature of the solution is above 150 degrees F., but below the boiling point, and the articles immersed. After removing and rinsing in water the relief is easily produced with pumice stone or other abrasives. This green color harmonizes well with the metal color.

The browns and blacks are coated on the metal in the same manner as described above under these headings; the solutions that are used hot give the best results, as the coating is more tenacious and better withstands the

buffing that is necessary when oxidizing the work. Many beautiful effects are produced by these combinations of colors, and while it is not difficult to relieve the rough surfaces of cast, stamped or pressed articles it requires considerable skill to properly relieve turned or polished surfaces.

Mottling

After properly buffing and cleaning the work, a handsome mottled effect can be produced by first immersing it in a boiling solution composed of 8 ounces sulphate of copper, 2 ounces salammoniac and 1 gallon water. This produces a light taffy color that soon changes to an olive green. The work should be removed when the taffy color appears and dipped in a second solution composed of 4 ounces sal-soda in 1 gallon water and that has the surface covered with a small amount of lard oil or gasoline. After that the work is again immersed in the first solution until the olive-green color is produced. The oil spreads over the surface and prevents the uniform action of the first solution, and hence the taffy and olive-green colors are mottled together with a pleasing effect. The same process might be used with different chemical solutions to mottle work with other combinations of colors.

Coloring Aluminum

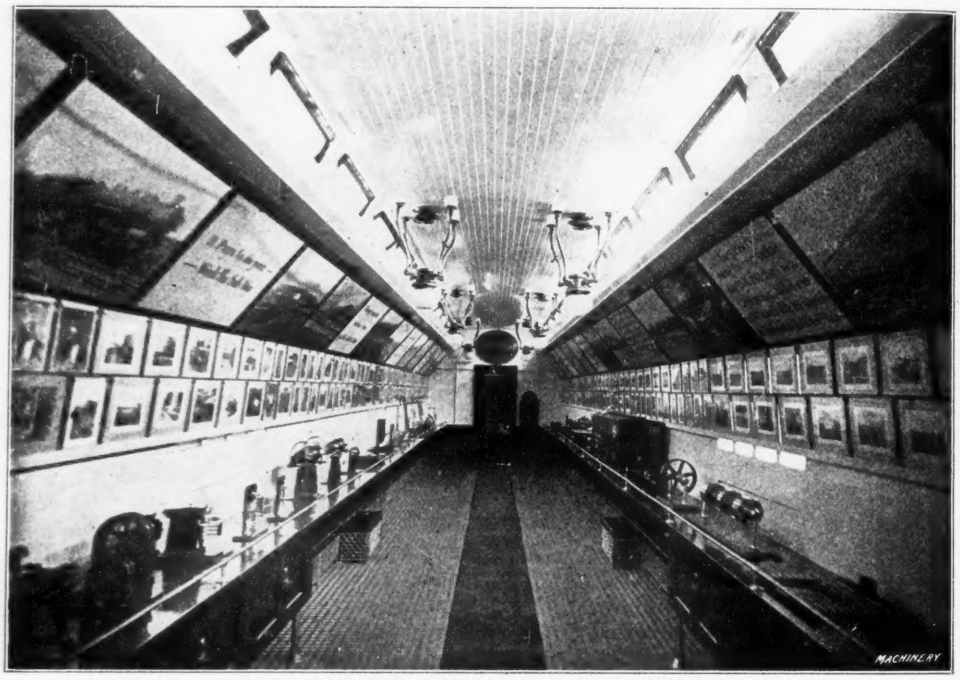
Aluminum is the most difficult of metals to color. Heretofore aluminum parts have only been colored by coating them with lacquers of different colors, but a process has recently been patented by Salamon Axelrod in Germany that produces different metallic colors. Either a neutral or alkaline cobaltous nitrate is made into a water solution into which the articles are dipped, or it may be painted on pieces too large to dip. After that the work is heated and the degree of heat determines the color. A low temperature produces a steel gray color that changes to brown with a higher heat and to a durable and permanent dead black when the temperature is still higher. Zinc, tin and other white metals may also be colored with similar cobalt salt solutions.

The gun-metal finish can be given aluminum by immersing it for from six to ten seconds in a cold solution of 12 parts hydrochloric acid, 1 part chloride of antimony and 87 parts distilled water. After that, thoroughly wash it in running water for several minutes, dry with heat and lightly buff with a high-speed wheel. The color penetrates the metal and its depth is governed by the length of time it is immersed. If immersed longer than ten seconds the solution should be weakened, as hydrochloric acid eats the metal.

Nearly any color can be plated on any of the metals or alloys by electro deposition, but this is an art or trade that requires experienced platers. Electrochroma is the name given a new plating process that promises to revolutionize the older methods of plating on colors. It produces any desired shade of green, blue, red, violet or yellow and black and white by immersion in the electrolyte for from one-half minute to two minutes. The work is made the cathode. One of its special features is the coloring of leaded glass. The lead can be given any desired color, while the glass is not affected but is left clean and with a clear luster. Heretofore the lead has been painted by hand, which was a long, tedious job, often consuming a day or more for one piece. It is also easy to match colors with this plating process and they are permanent enough not to require lacquering or waxing. The plating processes, however, are separate and distinct from those given above, as these do not require an electric current nor the high degree of knowledge and skill that goes with the plater's profession.

NEW YORK CENTRAL LINES SAFETY EXHIBIT CAR

The safety exhibit car is a new feature that has just been introduced by the New York Central Lines. This car has been put into service in connection with the work of the safety department of the company. It is intended primarily as an instruction car for the purpose of teaching the 125,000 or more employes of the railroad, the principle of "safety first," although it is also an interesting exhibit for the general public. An interior view of the car is shown in the accompanying illustration. Along each side is a shelf about 3 feet from the floor, which carries models of various metal- and wood-working machines used in the locomotive repair and car shops. These models are equipped with guards and various safety appliances such as are used on the machines which they represent. Along the side walls of the car above the models there are rows of pictures which form an instructive feature of the exhibit. On one side of the car, the pictures are devoted entirely to unsafe practices, there being about 100 photographs showing the common practices of railroad employes which cause accidents resulting in injuries to themselves and others. Beside a picture showing the improper or unsafe method, there is another showing the safe and proper way. Another section of the picture gallery deals with the trespassing question, there being a number of pictures showing to what extent persons risk their lives, needlessly, by trespassing on railroad property. Above these pictures there is a statement calling attention to the fact that nearly 5300 people were killed and 5700 injured, while trespassing on the railroads of the United States during the year ending June 30, 1912. Attached to the exhibit car, there will be a coach equipped with a stereopticon so that illustrated lectures on safety can be given to employes at various points along the New York Central Lines.



Interior of New York Central Lines Safety Exhibit Car

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AN INSTANCE OF RAPID GEAR-CUTTING

As an instance of the celerity with which up-to-date gear cutting concerns are required to work at times may be cited the making of a large special semi-steel gear by the Philadelphia Gear Works. This was a 56-inch, 3-inch circular pitch spur gear, with a 10-inch face, weighing 3340 pounds. The order came in on a Saturday morning and the pattern was made, sent to the foundry and the gear casting was returned on Wednesday morning. The gear blank was turned up Wednesday afternoon and Thursday morning, and the teeth were cut and finished by Friday morning. At the time this work was going through, a 15-inch mating pinion was carried through and shipped with the large gear on Friday afternoon.

STEAM POWER PLANT PIPING DETAILS—6

PROVIDING FOR EXPANSION AND CONTRACTION STRAINS IN PIPING SYSTEMS—(Continued)

BY WILLIAM F. FISCHER*

Exhaust mains as used in connection with condensing systems are known as vacuum exhaust mains, while those discharging the steam directly into the atmosphere are known as atmospheric exhaust mains. Atmospheric and vacuum exhaust mains expand and contract the same as do high-pressure steam mains, but not to the same extent, as the steam temperatures are lower. Exhaust mains are considerably larger than live-steam mains, however, and contain a much greater cross-sectional area of metal in the walls of the pipe; therefore they exert a greater thrust or pressure when expanding, which tends to strain the valves and fittings in the line, and even the machinery to which the exhaust piping is connected.

The thrust or pressure exerted by an exhaust main as it expands may be figured in exactly the same manner as described in the August number of MACHINERY. (See heading: "The Force of Expansion," page 959.) As exhaust mains are of greater diameter than live-steam mains, they will not bend, or buckle as easily when strained by expansion of the piping system, and this should be taken into account when making provision for expansion and contraction, even though the actual expansion be slight.

The materials commonly used in the construction of exhaust steam mains are steel, wrought iron and cast iron. Large vacuum exhaust mains are nearly always made of cast-iron pipe. Tables V, VI and VII are for use in figuring the expansion of atmospheric and vacuum exhaust mains. Table V is to be used for wrought iron pipe, Table VI for steel pipe and Table VII for cast-iron pipe. As the coefficients of expansion for the various metals vary slightly at different temperatures, this has been taken into account in preparing these tables. The values of the coefficients for different steam temperatures are given at the foot of each table.

Explanation of the Tables

The tables are to be used only for exhaust mains carrying steam at atmospheric pressure or lower. The temperature of exhaust steam at atmospheric pressure (14.7 pounds per square inch absolute pressure) is 212 degrees F. Steam at atmospheric pressure or lower will not be recorded on a steam gage, as the gage is so arranged that the pointer or hand registers zero at atmospheric pressure or lower. Steam pressures below atmospheric pressure are registered either on a vacuum gage or mercury column. A column of mercury approximately 30 inches high exerts a pressure of 15 pounds per square inch at its base; therefore, two inches of mercury is equivalent to approximately one pound pressure per square inch. If a vacuum gage attached to a condenser registers 26 inches it means that the condenser is working under a 26-inch vacuum, or a pressure approximately equal to 26÷2=13 pounds lower than atmospheric pressure, or 15—13=2 pounds absolute pressure, approximately. Absolute pressure is the pressure reckoned from a complete vacuum; therefore atmospheric pressure (zero pressure as shown by a steam gage) is, in reality, approximately 14.7 pounds per square inch above vacuum.

The upper line of each table gives the vacuum in inches of mercury, as recorded on a vacuum gage connected either to the condenser or to the exhaust main. In the second line of each table is given the temperature of the exhaust steam, corresponding to the vacuum, in inches of mercury. The figures in the body of the table represent the expansion, in decimals of an inch, per lineal foot of pipe. In the first column of the table the initial temperature of the pipe is given (temperature before steam is turned into the piping system). The values given in the last column are for exhaust mains carrying steam at atmospheric pressure. To find the expansion, in inches, of an exhaust main of a given length in feet, multiply the constants as given in the table, by the length of pipe, in feet.

Example:—A cast-iron vacuum exhaust main 35 feet long discharges its steam to a surface condenser which operates under a vacuum of approximately 26 inches of mercury, as recorded on a vacuum gage attached to the condenser, or the exhaust main. The initial temperature of the pipe before steam is turned into it is 30 degrees F. How much will the pipe expand? The expansion in inches, per foot of length, is found in Table VII under 26-inch vacuum, and opposite 30 degrees initial temperature of pipe, to be 0.00685, which, multiplied by 35 (the length of the pipe in feet), gives $0.00685 \times 35 = 0.24$ inch, or approximately ¼ inch.

Allowing for Expansion and Contraction in Steam and Exhaust Mains

It is considered good practice when figuring for expansion, to allow one-half the calculated amount when cutting the pipe to length.

Example:—If, in a run of pipe 75 feet between connections, or points where the branch pipes are taken off from the header,

TABLE V. EXPANSION OF WROUGHT IRON PIPE—VACUUM EXHAUST MAINS

Initial Temperature of Pipe in Degrees F.	Vacuum, in Inches of Mercury														
	28	26	24	22	20	18	16	14	12	10	8	6	4	2	Atmos. Pressure
	Temperature of Steam, Degrees F.														
	100	125	140	152	162	169	176	182	187	192	197	201	205	209	212
	Expansion in Inches per Foot of Length														
0	0.00792	0.00990	0.01130	0.01230	0.01310	0.01365	0.01422	0.01500	0.01543	0.01585	0.01625	0.01680	0.01692	0.01725	0.01750
10	0.00712	0.00910	0.01050	0.01150	0.01230	0.01285	0.01340	0.01420	0.01460	0.01500	0.01543	0.01575	0.01610	0.01642	0.01670
20	0.00635	0.00832	0.00970	0.01067	0.01150	0.01205	0.01262	0.01340	0.01380	0.01420	0.01460	0.01495	0.01527	0.01560	0.01585
30	0.00555	0.00752	0.00890	0.00986	0.01067	0.01123	0.01180	0.01255	0.01295	0.01340	0.01380	0.01410	0.01445	0.01480	0.01500
35	0.00515	0.00712	0.00850	0.00947	0.01028	0.01082	0.01140	0.01213	0.01255	0.01295	0.01340	0.01370	0.01403	0.01437	0.01460
40	0.00475	0.00673	0.00808	0.00905	0.00986	0.01042	0.01100	0.01172	0.01213	0.01255	0.01295	0.01330	0.01362	0.01395	0.01420
45	0.00435	0.00635	0.00768	0.00865	0.00947	0.01000	0.01060	0.01130	0.01172	0.01213	0.01255	0.01290	0.01320	0.01355	0.01380
50	0.00396	0.00594	0.00728	0.00825	0.00905	0.00963	0.01020	0.01090	0.01130	0.01172	0.01213	0.01245	0.01280	0.01312	0.01340
55	0.00356	0.00555	0.00687	0.00784	0.00865	0.00922	0.00978	0.01050	0.01090	0.01130	0.01172	0.01201	0.01240	0.01272	0.01295
60	0.00316	0.00515	0.00647	0.00743	0.00825	0.00882	0.00938	0.01010	0.01050	0.01090	0.01130	0.01165	0.01197	0.01230	0.01255
65	0.00277	0.00475	0.00607	0.00703	0.00784	0.00840	0.00897	0.00965	0.01010	0.01050	0.01090	0.01120	0.01155	0.01190	0.01213
70	0.00238	0.00435	0.00567	0.00663	0.00743	0.00800	0.00857	0.00925	0.00965	0.01010	0.01050	0.01080	0.01115	0.01148	0.01172
75	0.00198	0.00936	0.00525	0.00623	0.00703	0.00760	0.00817	0.00885	0.00925	0.00965	0.01010	0.01040	0.01072	0.01108	0.01130
80	0.00158	0.00356	0.00485	0.00582	0.00663	0.00720	0.00776	0.00843	0.00885	0.00925	0.00965	0.01000	0.01030	0.01065	0.01090
90	0.00079	0.00277	0.00405	0.00502	0.00582	0.00638	0.00695	0.00760	0.00800	0.00843	0.00885	0.00917	0.00950	0.00983	0.01010
100	0	0.00198	0.00324	0.00420	0.00502	0.00558	0.00615	0.00677	0.00720	0.00760	0.00800	0.00835	0.00867	0.00900	0.00925

Machinery

Coefficients of expansion used in computing the above table: Steam temperatures 100 degrees to 125 degrees inclusive, 0.00000660; steam temperatures 140 degrees to 176 degrees inclusive, 0.00000673; steam temperatures 182 degrees to 212 degrees inclusive, 0.00000688.

* Address: 3959 Fulton Ave., Woodhaven, N. Y.

the expansion is calculated to be 2 inches, it would be good practice to allow one-half of this amount when cutting the pipe to length. In other words, the total length of pipe between connections should be 75 feet minus 1 inch. The steam-fitter takes up the other inch, putting a cold strain on the pipe and springing the bends sufficiently to make up the joints. to strain the piping sufficiently to make up the joints. If one-half, or any part, of the expansion is allowed for when cutting the pipe to length, the steam-fitter should be notified to that effect, as otherwise he is apt to find the pipe short and install a "Dutchman" in the line, not knowing that expansion had been allowed for in the shop.

TABLE VI. EXPANSION OF STEEL PIPE—VACUUM EXHAUST MAINS

Initial Temperature of Pipe in Degrees F.	Vacuum, in Inches of Mercury														
	28	26	24	22	20	18	16	14	12	10	8	6	4	2	Atmos. Pressure
	Temperature of Steam, Degrees F.														
	100	125	140	152	162	169	176	182	187	192	197	201	205	209	212
	Expansion in Inches per Foot of Length														
0	0.00678	0.00850	0.00968	0.01050	0.01120	0.01168	0.01215	0.01285	0.01320	0.01355	0.01400	0.01420	0.01450	0.01480	0.01500
10	0.00610	0.00780	0.00898	0.00980	0.01050	0.01100	0.01147	0.01215	0.01250	0.01285	0.01320	0.01350	0.01380	0.01400	0.01430
20	0.00542	0.00712	0.00830	0.00913	0.00980	0.01030	0.01078	0.01145	0.01180	0.01215	0.01250	0.01280	0.01310	0.01335	0.01355
30	0.00425	0.00645	0.00760	0.00893	0.00913	0.00960	0.01010	0.01073	0.01110	0.01145	0.01180	0.01210	0.01238	0.01265	0.01285
35	0.00440	0.00610	0.00725	0.00810	0.00878	0.00927	0.00975	0.01040	0.01073	0.01110	0.01145	0.01173	0.01200	0.01230	0.01250
40	0.00407	0.00575	0.00691	0.00775	0.00893	0.00892	0.00940	0.01002	0.01040	0.01073	0.01110	0.01140	0 01165	0.01195	0.01215
45	0.00373	0.00542	0.00655	0.00740	0.00810	0.00857	0.00905	0.00968	0.01002	0.01040	0.01073	0.01100	0.01130	0.01160	0.01180
50	0.00339	0.00518	0.00622	0.00705	0.00775	0.00823	0.00870	0.00933	0.00968	0.01002	0.01040	0.01067	0.01095	0.01123	0.01145
55	0.00305	0.00425	0.00587	0.00670	0.00740	0.00788	0.00835	0.00898	0.00933	0.00968	0.01002	0.01030	0.01060	0.01090	0.01110
60	0.00271	0.00440	0.00553	0.00635	0.00705	0.00753	0.00800	0.00863	0.00898	0.00933	0.00968	0.00997	0.01025	0.01052	0.01073
65	0.00237	0.00407	0.00518	0.00600	0.00670	0.00718	0.00767	0.00827	0.00863	0.00898	0.00933	0.00960	0.00990	0.01018	0.01040
70	0.00203	0.00373	0.00483	0.00567	0.00635	0.00685	0.00733	0.00792	0.00827	0.00863	0.00898	0.00926	0.00955	0.00983	0.01002
75	0.00169	0.00339	0.00450	0.00532	0.00600	0.00650	0.00698	0.00755	0.00792	0.00827	0.00863	0.00890	0.00920	0.00948	0.00968
80	0.00136	0.00305	0.00415	0.00497	0.00567	0.00615	0.00663	0.00720	0.00755	0.00792	0.00827	0.00855	0.00885	0.00912	0.00933
90	0.00068	0.00237	0.00345	0.00428	0.00497	0 00545	0.00594	0.00650	0.00685	0.00720	0.00755	0.00785	0.00815	0.00842	0.00863
100	0	0.00169	0.00276	0.00359	0.00428	0.00477	0.00525	0.00580	0.00615	0.00650	0.00685	0.00715	0.00742	0.00770	0.00792

Machinery

Coefficients of expansion used in computing the above table: Steam temperatures 100 degrees to 125 degrees inclusive, 0.00000565; steam temperatures 140 degrees to 176 degrees inclusive, 0.00000576; steam temperatures 182 degrees to 212 degrees, 0.00000590.

When steam is turned into the piping system, the elongation of the main, due to expansion, removes the cold strain, and in this way the fittings, valves and pipe joints are, at any time, strained only one-half as much as if none, or all, of the expansion were allowed for when cutting the pipe to length.

Most of the large concerns making a specialty of furnishing and erecting piping material have adopted this rule in their shops and it has proved to be satisfactory for conditions in general. When estimating the pipe length, some designers allow for all of the expansion in the line, with the result that when the steam-fitter comes to erect the piping system he finds it necessary, especially in long lines of piping, to install what is known as a "Dutchman" or filler piece (see Fig. 41) in order to make up the required length, as he finds it impossible

Anchoring Steam Mains

The method of anchoring steam main and branch pipes and the location of the anchors are very important details which should be given the proper attention when designing and erecting a piping system. If the anchors are not properly located the expansion of the piping may throw severe strains on the joints, resulting in loose gaskets and bolts and causing leakage. A steam main should never be anchored at two or more points in its length, unless an expansion bend or joint is provided at some point between the anchors; otherwise the anchors would be very apt to fail, or the pipe would bow or spring out of shape and strain the joints of the main header and branch pipes.

No special rules can be given for designing and anchoring

TABLE VII. EXPANSION OF CAST-IRON PIPE—VACUUM EXHAUST MAINS

Initial Temperature of Pipe in Degrees F.	Vacuum, in Inches of Mercury														
	28	26	24	22	20	18	16	14	12	10	8	6	4	2	Atmos. Pressure
	Temperature of Steam, Degrees F.														
	100	125	140	152	162	169	176	182	187	192	197	201	205	209	212
	Expansion in Inches per Foot of Length														
0	0.00720	0.00900	0.01028	0.01118	0.01190	0.01240	0.01292	0.01365	0.01402	0.01440	0.01480	0.01510	0.01547	0.01570	0.01590
10	0.00650	0.00830	0.00955	0.01042	0.01115	0.01168	0.01220	0.01290	0.01330	0.01365	0.01402	0.01432	0.01462	0.01492	0.01515
20	0.00576	0.00757	0.00882	0.00970	0.01042	0.01093	0.01145	0.01215	0.01253	0.01290	0.01330	0.01358	0.01388	0.01420	0.01440
30	0.00505	0.00685	0.00808	0.00897	0.00970	0.01020	0.01070	0.01140	0.01178	0.01215	0.01253	0.01282	0.01312	0.01342	0.01365
35	0.00468	0.00650	0.00772	0.00860	0.00933	0.00985	0.01035	0.01103	0.01140	0.01178	0.01215	0.01245	0.01275	0.01305	0.01330
40	0.00433	0.00613	0.00735	0.00823	0.00897	0.00948	0.01000	0.01065	0.01103	0.01140	0.01178	0.01208	0.01238	0.01267	0.01290
45	0.00396	0.00576	0.00698	0.00786	0.00860	0.00912	0.00963	0.01028	0.01065	0.01103	0.01140	0.01170	0.01200	0.01230	0.01253
50	0.00360	0.00540	0.00661	0.00750	0.00823	0.00875	0.00926	0.00990	0.01028	0.01065	0.01103	0.01132	0.01163	0.01192	0.01215
55	0 00324	0.00505	0.00625	0.00712	0.00786	0.00838	0.00890	0.00953	0.00990	0.01028	0.01065	0.01095	0.01125	0.01155	0.01178
60	0.00288	0.00468	0.00588	0.00675	0.00750	0.00800	0.00855	0.00915	0.00953	0.00990	0.01028	0.01058	0.01088	0.01118	0.01140
65	0.00252	0.00433	0.00550	0.00638	0.00712	0.00765	0.00815	0.00878	0.00915	0.00953	0.00990	0.01020	0.01050	0.01080	0.01103
70	0.00216	0.00396	0.00515	0.00602	0.00675	0.00727	0.00778	0.00840	0.00878	0.00915	0.00953	0.00983	0.01013	0.01042	0.01065
75	0.00180	0.00360	0.00477	0.00565	0.00638	0.00690	0.00742	0.00803	0.00840	0.00878	0.00915	0.00945	0.00975	0.01005	0.01028
80	0.00144	0.00324	0.00441	0.00528	0.00602	0.00653	0.00705	0.00765	0.00803	0.00840	0.00878	0.00908	0.00938	0.00968	0.00990
90	0.00072	0.00252	0.00367	0.00455	0.00528	0.00580	0.00632	0.00690	0.00728	0.00765	0.00803	0.00883	0.00863	0.00893	0.00915
100	0	0.00180	0.00294	0.00382	0.00455	0.00507	0.00558	0.00615	0.00653	0.00690	0.00728	0.00758	0.00788	0.00818	0.00840

Machinery

Coefficients of expansion used in computing the above table: Steam temperatures 100 degrees to 125 degrees inclusive, 0.00000600; steam temperatures 140 degrees to 176 degrees inclusive, 0.00000612; steam temperatures 182 degrees to 212 degrees inclusive, 0.00000626.

against expansion and contraction. The designer must depend more or less upon his own judgment in placing the expansion bends and anchors where they will do the most good. Pipe anchors should always be supported on rigid foundations, or steelwork, in order to resist the severe strains which they are subjected to. Any movement of a pipe anchor, or its foundation, defeats the purpose for which it was intended and is liable to cause the expansion strains to come on some member of the piping system where least desired, with subsequent damage to the steam main or machinery to which it is connected.

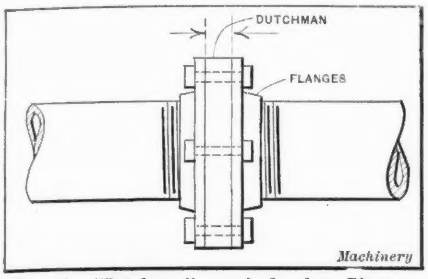


Fig. 41. "Dutchman" required when Pipes are cut Short enough to allow for All Expansion

As a guide in placing anchors and bends, see Fig. 39 (August number of MACHINERY) and also the following examples and illustrations showing several methods of caring for expansion and contraction.

Caring for Expansion and Contraction

Having determined the amount a steam pipe will expand in service, the next question that arises is how the expansion shall be taken care of so that the piping system can expand and contract freely without injury to the joints, valves and fittings in the line.

For steam mains of moderate length—say 50 to 100 feet—where flexible pipe connections are provided between the main header and the engines and boilers, the main header may be

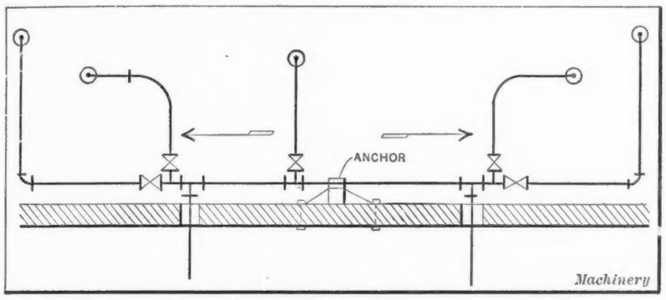


Fig. 42. Diagram showing Method of anchoring a Steam Line of Moderate Length

anchored rigidly at, or near the center of the line, thus allowing expansion in both directions, as indicated by the arrows in Fig. 42. In this case, the joints nearest the anchor are subjected to the least strain, the greatest strain falling on the joints near the end of the header. If the lines are very long it is usually better to install an expansion bend or loop in the header somewhere between the different branches, as shown in Fig. 43, provided the expansion in the line is sufficient to warrant the use of a loop. In Fig. 43, the main header is shown anchored close to the branch pipes at *A* and *B*, and an expansion bend is placed at any convenient point between the branch pipes, as shown at *D*. In very long pipe lines, it may be necessary to anchor the expansion bend at *C*, in order to prevent the main header from buckling sideways. When heated, the main header expands in the direction of the arrows, tending to close the bend; thus, in order to insure sufficient elasticity, the expansion bend should be designed to suit the elongation of the main header. If one-half of the expansion between points *A* and *B* is allowed for when cutting the pipe to length, expansion bend *D* would be sprung or stretched this amount during erection in order to make up the pipe joints, and would thus take care of approximately twice as much expansion as the same bend would if none of the expansion were allowed for when cutting the pipe. Rules for designing expansion bends will be given in a later installment.

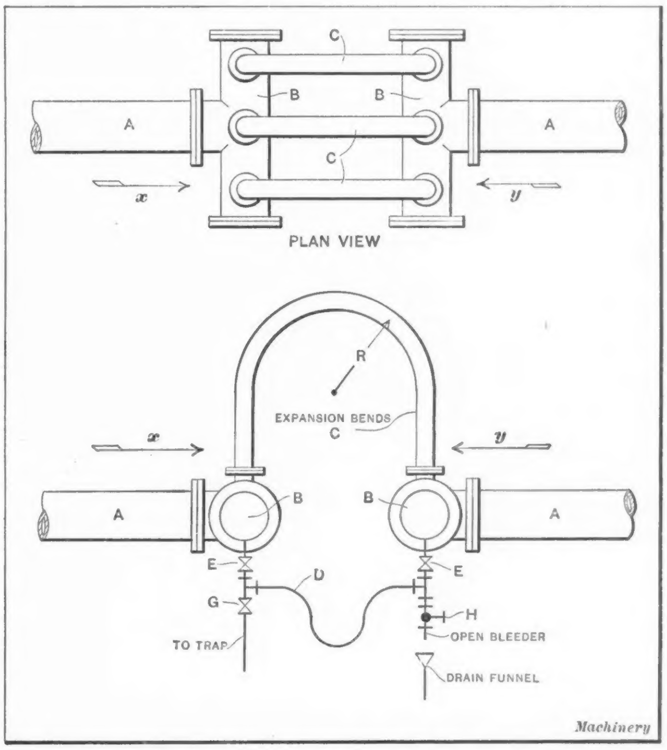


Fig. 44. An Expansion Bend formed of Three Pipes to secure Flexibility

The old type of slip-expansion joints are seldom if ever used on high-pressure steam mains, as there is always more or less danger of the joint pulling apart from the pressure in the main. These joints, when used in the past, have proved a constant source of trouble and expense, requiring frequent repacking and adjustment, and almost invariably have been discarded for the more modern type of expansion bend, or balanced expansion joint now on the market. The balanced type of expansion joint is constructed so that the pressure is equalized in such a way as to prevent the joint from pulling apart. For high-pressure pipe work, expansion bends should always be given the preference over all types of expansion joints, provided there is sufficient space available to accommodate the bend. Expansion bends act as a spring, the deflection of the bend being distributed uniformly throughout the bend, thus serving to take up any movement of the pipe due to expansion or contraction.

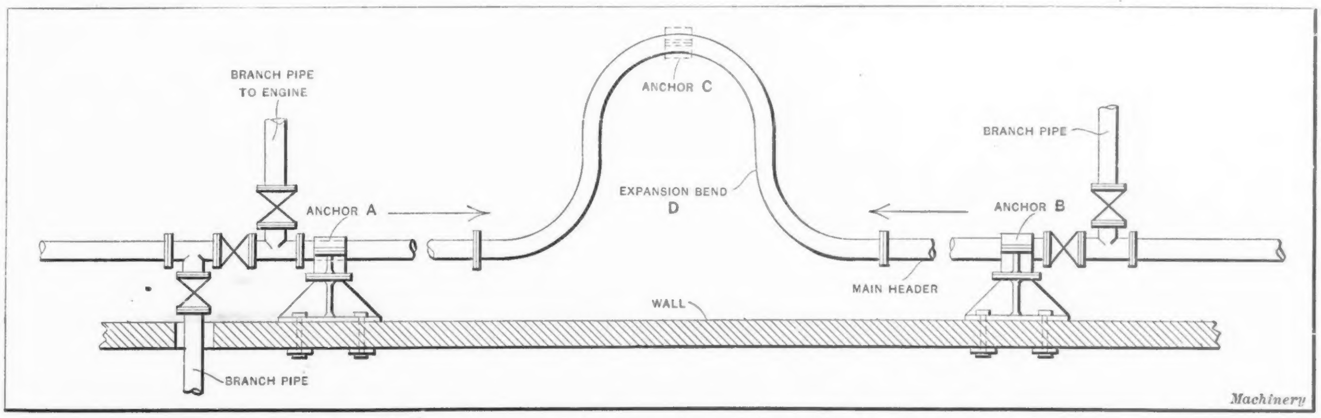
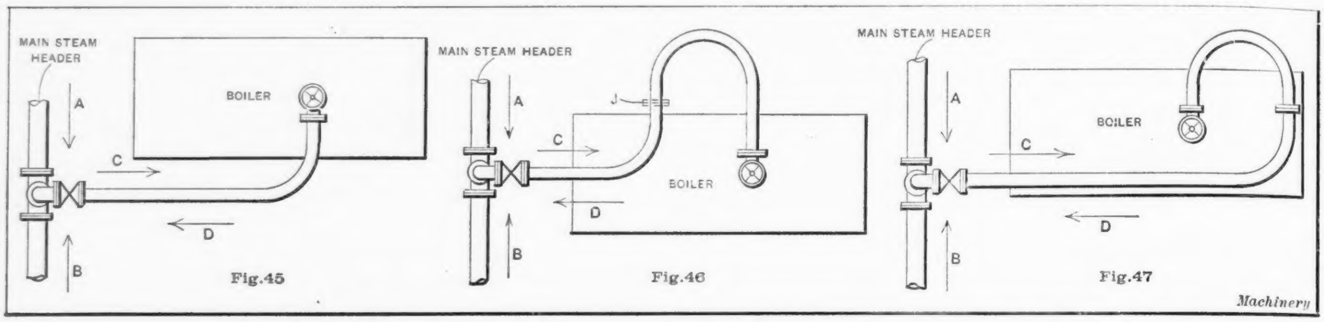


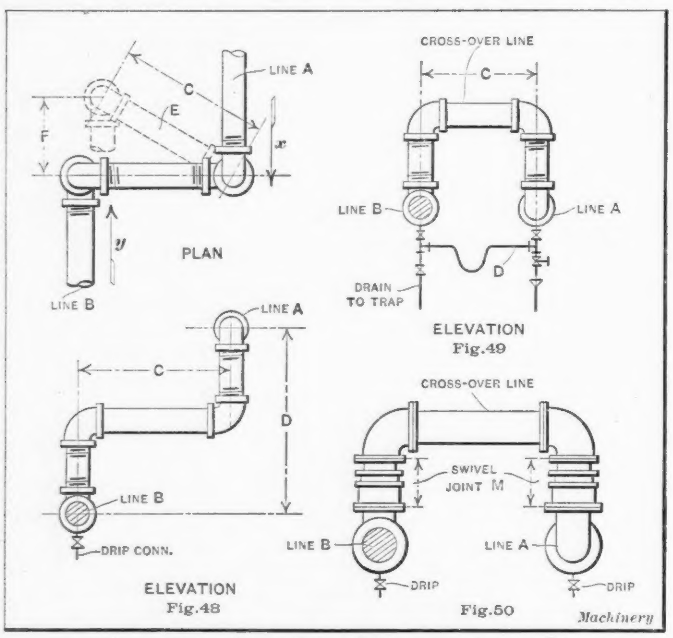
Fig. 43. Illustrating Method of compensating for Expansion and Contraction by the Use of an Expansion Bend

Expansion bends made of large pipe are considerably stiffer and more rigid than bends of smaller pipe and do not deflect as readily unless bent to a very large radius. Where lack of space prohibits the use of an extremely large single-expansion bend, the expansion in a steam main of large diameter may be taken care of as shown in Fig. 44. In this case, the main header *A* is broken as shown, making connection with manifolds *B*, to which are connected U-bends *C*. The combined areas of bends *C* should be equivalent to, or greater than, the area of the main header *A*, in order that the flow of steam may not be retarded at this point. Of course, the use of a number of small bends *C* makes a more flexible connection than would a single bend of the same size as the main header, if bent to the same radius as the smaller bends. Referring to the elevation, shown in Fig. 44, we see that as the water of condensation tends to lodge in the manifolds *B* until it is picked up by the rapidly flowing steam and carried over at high velocity through bends *C*, it might cause a dangerous "water hammer" in the line. This should be guarded against by connecting a drain pipe *D* to the bottom of each manifold *B* as shown. Drain pipe *D* should be bent into the form of an expansion loop, in order to prevent expansion strains on the small valves and fittings in the drain line as the main header expands, as indicated by arrows *x-y*. Drain pipe *D* should be connected to a steam trap or other drip return system, through valve *G*. It is also advisable to provide an open bleeder, or emergency "test drain" connection, as shown at *H*, leading to an open funnel-shaped fitting, for testing or clearing the line of water when shutting down. Valves *E* are for emergency use only, being used in case it becomes necessary to disconnect or repair the drain pipe; they should always remain wide open during operation, so that if the trap or drip return system failed to operate, the water of condensation entering one manifold would flow down through drain pipe *D* into the bottom of the other manifold, where it would be carried on by the steam flow. In this manner, a dangerous water pocket could be avoided. (For further information regarding drip connections of this kind, see Fig. 28, page 705, MACHINERY, May, 1913.)

Figs. 45, 46 and 47 show three different methods of providing for expansion and contraction in the branch pipes connecting the boilers with the main header. The connections take care of any movement of the pipes in either direction, as shown by the arrows *A*, *B*, *C* and *D*. The connection illustrated in Fig. 45 is not quite as flexible as that shown in Figs. 46 and 47. The connection, Fig. 47, requires more pipe than either of the other two. The connections, Figs. 46 and 47, are preferable where considerable movement has to be taken care of in the direction indicated by arrows *A* and *B*. The connection, Fig. 46, may be made up of two bends, if so desired, by using a flanged joint at *J*.



Figs. 45, 46 and 47. Different Methods of providing for Expansion and Contraction in Branch Pipes



Figs. 48, 49 and 50. Swing Joints to compensate for Expansion and Contraction

Swing Joints

Figs. 48, 49 and 50 show different methods of taking care of expansion strains in steam piping by what are known as "swing joints." Figs. 48 and 49 show methods usually employed in making up swing joints on small and medium size pipe lines, where screwed fittings are used. In Fig. 48, pipe lines *A* and *B* are at different levels, as indicated at *D*, and are offset as at *C*. When the pipe expands in the direction of the arrows *x* and *y*, the pipe swings, or rotates on the threaded joints sufficiently to take up the expansion *F*, assuming the position shown by the dotted lines *E*. If, in this case, the steam flow were in the direction of arrow *x*, flowing from line *A* to line *B*, any water of condensation forming in the line, or carried over from the boilers with the steam, would be carried on by the steam flow without danger of water hammer at this point; but, if the steam flow were in the direction of arrow *y*, line *A* being at a higher elevation than line *B*, would form a water pocket in the riser. To prevent this, the line should be dripped at the low point as shown in the elevation.

Fig. 49 shows an arrangement of swing joints where pipe lines *A* and *B* are on the same level, but offset as at *C*. With this arrangement, the vertical legs of the cross-over connection will form a dangerous water pocket in the lines unless properly drained at the inlet side. In a case of this kind it might be advisable to connect a drain pipe to both vertical legs of the cross-over line and connect them as at *D*.

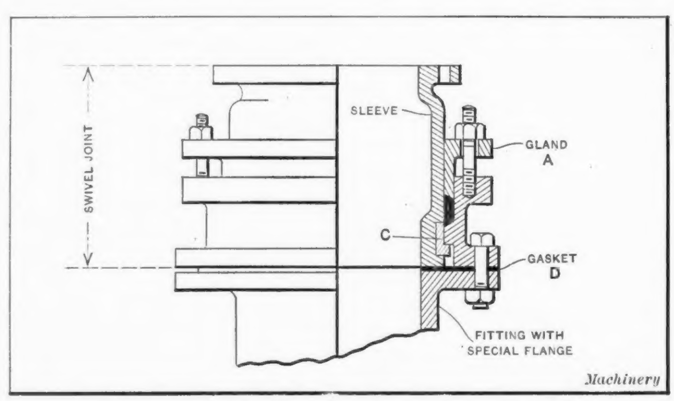


Fig. 51. Detail of Crane Co.'s Swivel Expansion Joint

Fig. 50 shows a method of connecting swing joints where either bolted flanged pipe and fittings are used or screwed pipe with screwed fittings. In this case, the swivel expansion joints *M* are connected to each vertical leg of the cross-over line, and rotate in a packed gland as the pipe expands.

Fig. 51 shows an enlarged detail and part section of one of these joints, as manufactured by the Crane Co. The upper half of these joints has flanges which match the fittings. The lower body flanges are of a special diameter and have special drilling; for this reason it is necessary to provide a special flange on the fittings to which the lower flanges connect. These swivel joints are constructed in such a manner that it is impossible for the sleeves to blow out or pull apart without shearing the circumferential bushing ring *C*. The joint, when made up, is packed steam-tight by screwing down the packing gland *A*. The upper sleeves of these joints will make a complete revolution while under pressure, with no danger of the joint blowing out or pulling apart.

Swivel expansion joints may be obtained with either screwed or flanged ends, as desired, for steam pressures as high as 250 pounds per square inch. For high pressures, however, it is advisable to use long radius steel pipe bends wherever possible in preference to expansion joints, or swing joints of any type. Pipe bends decrease the number of joints in the line, and if they are properly proportioned for the service will give far more satisfaction than the methods described in the foregoing. Swing joints are used mostly for low-pressure steam heating work, to take up the expansion in the different branches of the piping system, pipe risers, etc.

* * *

FORMULA FOR DETERMINING THE BALL CIRCLE DIAMETER FOR BALL BEARINGS*

BY WILBUR C. PRIOR†

The formula which is developed in this article is one which the writer has found very useful in solving ball-bearing problems, and it can also be used to advantage in other kinds of work. Its use will be illustrated at the end of this article. This is the only formula known to the writer for figuring the ball circle diameter where there is a space between consecutive balls. Smith and Marx, in their book on machine design, give the formula $R = \dfrac{r}{\sin \dfrac{180 \text{ deg.}}{n}}$ but this applies only to full type bearings and, even when it can be used, it is more cumbersome than the one given below:

In the diagram let:

D = ball circle diameter;
d = ball diameter;
S = space between balls;
n = number of balls.

It should be noticed that the distance S is measured on a straight line joining the centers of adjacent balls.

Construction

Draw the perpendicular bisector XZ of the chord WY. This line will pass through the center of the circle (A perpendicular bisector of a chord passes through the center of the circle).

Derivation of the Formula

In triangle XYZ:

$$\text{Side } XY = \frac{d + S}{2}$$

$$\text{Side } YZ = \frac{D}{2}$$

$$\text{Angle } XZY = \frac{180}{n}$$

$$\text{Cosecant } XZY = \frac{\frac{D}{2}}{\frac{d + S}{2}} = \frac{D}{2} \times \frac{2}{d + S} = \frac{D}{d + S}$$

Denoting cosecant XZY by C we have:

$$C = \frac{D}{d + S}$$

$$D = C\ (d + S) = \text{diameter of ball circle.}$$

* For further information on ball bearing design see MACHINERY'S Data Sheet No. 25, entitled "Formulas for Ball and Roller Bearings."
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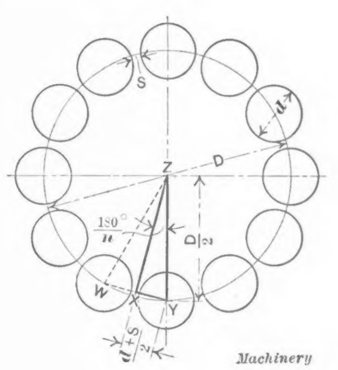
Example

The following example illustrates the use of the formula in connection with the values of C corresponding to different values of n in the table. Given the number and size of the balls, and the space required between consecutive balls; to find the ball circle diameter:

Let number of balls = 17;
diameter of balls = $\frac{5}{16}$ inch;
space between balls = ⅛ inch.

Then looking in the table opposite 17 in the n column we find 5.4464 in the C column.

TABLE OF CONSTANTS FOR FINDING BALL CIRCLE DIAMETERS WITH SPACE BETWEEN BALLS



n	C	n	C	n	C
3	1.1547	13	4.1804	23	7.3496
4	1.4142	14	4.4964	24	7.6613
5	1.7013	15	4.8097	25	7.9787
6	2.0000	16	5.1258	26	8.3000
7	2.3051	17	5.4464	27	8.6138
8	2.6131	18	5.7588	28	8.9294
9	2.9238	19	6.0779	29	9.2445
10	3.2361	20	6.3924	30	9.5668
11	3.5502	21	6.7106	31	9.8785
12	3.8637	22	7.0282	32	10.2110

n	C	n	C
33	10.529	63	20.112
34	10.826	64	20.398
35	11.167	65	20.692
36	11.474	66	20.996
37	11.803	67	21.387
38	12.101	68	21.629
39	12.442	69	21.960
40	12.745	70	22.301
41	13.064	71	22.654
42	13.399	72	22.925
43	13.719	73	23.298
44	14.020	74	23.586
45	14.335	75	23.880
46	14.664	76	24.182
47	14.971	77	24.480
48	15.290	78	24.811
49	15.623	79	25.137
50	15.926	80	25.471
51	16.241	81	25.815
52	16.570	82	26.169
53	16.911	83	26.410
54	17.198	84	26.780
55	17.531	85	27.033
56	17.858	86	27.421
57	18.141	87	27.686
58	18.491	88	28.092
59	18.794	89	28.370
60	19.107	90	28.654
61	19.431	91	29.090
62	19.766	92	29.388

Machinery

Substituting known values in the formula $D = C\ (d + S)$ we obtain $D = 5.4464\ (5/16 + ⅛) = 2.382$ inches = diameter of ball circle.

* * *

PROJECTILE FOR DESTROYING AEROPLANES

The means for destroying aeroplanes and airships are keeping pace with the new inventions made in the aeronautical field. Thus, for example, tests have been made in Germany with a special projectile intended for the destruction of dirigible airships. The projectile is fired from a regular army rifle, and is provided with small wings or projections which open during the flight of the projectile under the influence of a spring, which latter is compressed while the projectile is still in the rifle barrel but expands as soon as it has passed from the muzzle. An ordinary bullet leaves such a small hole in the envelope of the dirigible that the gas escapes very slowly. The wings or projections of the present bullet will tear a hole of considerable size in the fabric and in addition will cause a device contained in the bullet to ignite the gas.

* * *

WAGES OF GERMAN LABORERS

Robert Grimshaw, of Dresden, Germany, writes that the wages of ordinary day laborers in twenty-three German cities of over two thousand inhabitants are officially reported as follows: Munchen (Munich), 3.70 marks (88 cents); Berlin, Charlottenburg and Rixdorf, 3.60 marks (85.7 cents); Leipzig, Düsseldorf and Stuttgart, 3.50 marks (83.3 cents); Hamburg, Frankfurt-on-Main, Nurnberg and Essen, 3.40 marks (80.9 cents); Dresden, Dortmund, Koln (Cologne) and Duisberg, 3.25 marks (77.4 cents); Bremen and Kiel, 3.20 marks (76.2 cents); Breslau, Hannover and Magdeburg, 3.00 marks (71.4 cents); Königsberg, 2.75 marks (65.5 cents); Chemnitz and Stettin, 2.50 marks (59.5 cents).

AUTOMOBILE REAR AXLE DESIGN

A DISCUSSION OF CHAIN AND GEAR TRANSMISSIONS

BY K. W. NAJDER*

There are two important methods of transmitting the torque of the motor to the driving wheels of a motor-driven vehicle—either by means of a chain or a shaft—and each of them possesses advantages and disadvantages.

Chain Drive

In almost every instance the chain is exposed to dust and dirt which causes it to wear out, and that means a considerable loss of power, or in other words, less efficiency. As the chain is placed between the frame and the wheel the distance between the wheel and the spring seat is greater, and in consequence the bending moment of the axle is much higher, as the bending moment varies directly with the distance of the spring seat from the wheel. Another great objection to the chain drive is the noise.

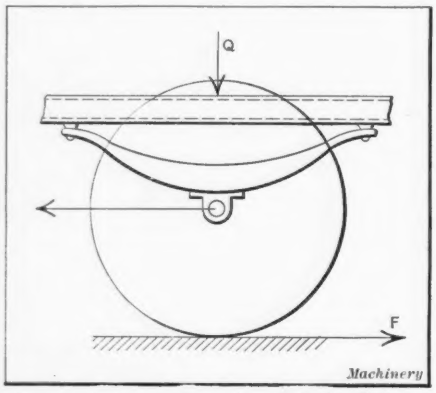


Fig. 1. Diagram illustrating Relation between Weight of Car and Retarding Force

On the other hand, when chain drive is applied, the rear axle is made from one piece, and is not parted in the center as is the case with a shaft driven axle. Further, in regard to the bending stresses, the axle can obtain the most favorable I-section. It does not carry any heavy parts, like differential gears and their housing, and being light and free from other weights, it can travel a rough road much more easily, is not subjected to very severe shocks, the bumps of the axle are reduced and in consequence the life of the tires and the rims is much longer. The shaft driven axles of heavy-duty trucks would have to carry the heavy weight of differential gears and their housings, and that is the main reason why the chain drive is applied to heavy commercial and racing cars.

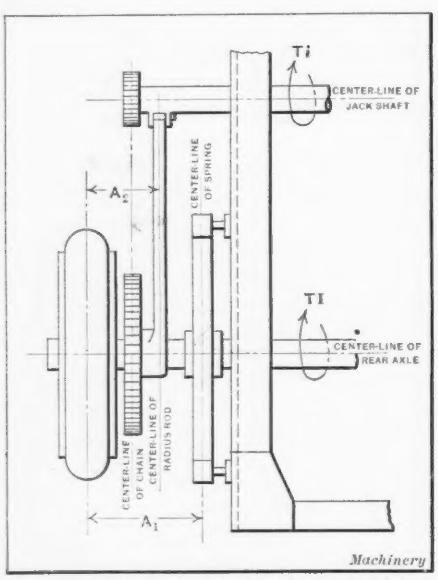


Fig. 2. Diagram showing Method of calculating Rear Axle Stresses with Chain Drive

Shaft Drive

The advantages and disadvantages of a shaft drive can be seen from what was said in regard to the chain drive. As long as the housings of shaft-driven axles were made of cast iron or steel, the shaft drive was not much in favor as the axles were heavy, the strains were great, the axles were subjected to severe shocks and bumps from the ruts of the road, and the life of the rims and tires could not be very long. With the introduction of pressed steel housings, however, the shaft drive began to receive preference over the chain drive.

An endeavor is being made to make all parts of the shaft driven axle out of pressed steel, and by that means the weight can be considerably reduced, but it will not lower the strains in the axle to any appreciable extent, as there will still be heavy parts which cannot be made lighter, such as bevel gears, ball bearings, and ball bearing housings. Generally the differential housings are supported from below by means of truss rods in order to reduce the bending moment due to the weight of the differential housings.

The rear axle pushes the car; consequently, means have to be provided to transmit this shoving force from the axle to the frame. The simplest way is to use the front end of the side springs for this purpose, and in such cases the front ends of the springs are fixed to the frame. The springs have to be strong enough to transmit this power and to withstand the skidding of the wheels; consequently they should also be figured for buckling. In heavy cars, radius rods are provided for this purpose. Another way to transmit this thrust is by means of a propeller shaft housing, the front end of which is fastened by means of a fork, or a globe joint to a cross member of the frame, or to the rear end of the transmission case. In order to make the construction sufficiently rigid, rods are run diagonally from the ends of the axle toward the front end of the propeller shaft housing.

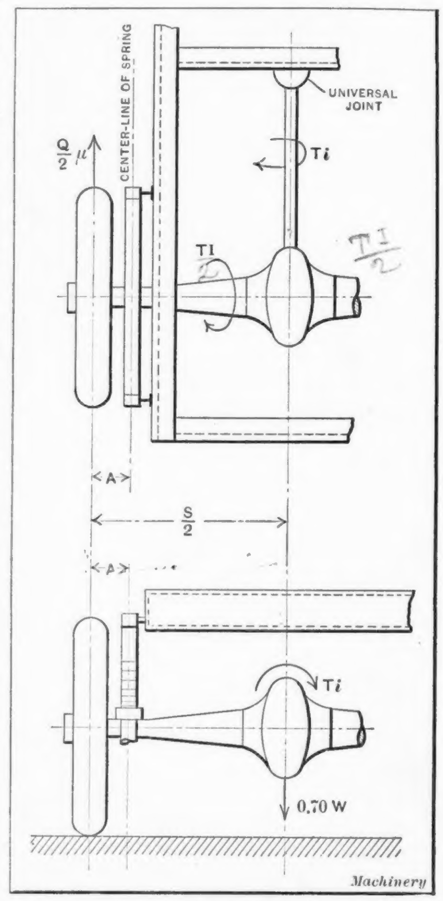


Fig. 3. Diagram for determining Rear Axle and Housing Stresses with Shaft Drive

Besides the shoving force, there is another force to be taken care of with the shaft drive construction. This is the torque exerted by the motor. On account of this torque, in starting the car forward the driving pinion tends to climb up on the gear and to carry the propeller shaft with it. The whole housing also tends to rotate in a direction opposite to that of the road wheels, and this must be prevented by proper means. The simplest way is to let the front end of the springs perform this duty. In this case the spring seats have to be fastened rigidly to the housing, and two universal joints between the axle and transmission have to be provided. In heavier cars, a special torque rod is attached near the center of the axle housing, the front end of which is pivoted, with coil springs interposed, to a cross member of the frame. In this case, two universal joints are usually provided also. If the propeller shaft housing is utilized to transmit the shoving force to the frame, as mentioned above, this same member can also be used for transmitting the torque. In this case, only one universal joint is required, but its fulcrum has to coincide with the center of the globe joint, or the fork on the front end of the construction. There should be sliding movements in the universal joints, and whenever the torque rod is applied the spring seats have to be arranged so that they can swivel around the axle housing.

The object of the shaft driven axle is to transmit power from the motor to the driving wheels. It is subjected to severe shocks and stresses due to the bumps and ruts of the road,

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and has to withstand all strains and stresses of stopping the car. In addition, it must carry more than half the weight of the car, and its load. The slightest deviation of a shaft from the correct line or the slightest inaccuracy in the meshing of the gears puts additional strains on the motor. To secure and maintain perfect meshing of the gears, good bearings are absolutely essential and they ought to be adjustable to take up inevitable wear. The weight of the car should be carried by the housing, and all shocks transmitted by it to the frame. The live axle should be absolutely free from all weights and shocks; it should transmit only the torque of the motor to the rear wheels, and should be subjected only to torsional stresses. In the chain construction, the jackshaft applies the power, and the dead rear axle only carries the load.

Adhesion

Let Q pounds indicate that portion of the weight of the car which is ried on the rear wheels. In Fig. 1, the weight Q is communicated to the ground through a wheel. No matter how much the friction between the wheel and the ground may be, the retarding force F cannot exceed the weight Q. If a greater force than this is applied to move the vehicle forward, the wheel will not only turn but it will also slip on the ground. Then, because the retarding force F cannot even be equal to Q, if the coefficient of friction of the wheel on the ground is μ, $F = \mu Q$ and that is the maximum condition. This factor μ is called the factor of adhesion. The coefficient of friction on an average road is 0.60. We see that we can make the calculations for the rear axle, starting with the torque of the motor, or we can start with the portion of the weight of the car which is carried on the rear wheels.

Rear Axle Calculations—Chain Drive

In Fig. 2, let

Q = Load on rear wheels;
r = Radius of the rear wheel;
i = Ratio of transmission;
I = Combined ratio of transmission and ratio of rear axle;
μ = Coefficient of friction = 0.6;
T = Torque of motor;

$$TI = Qr\mu \text{ and for one wheel } \cancel{TI} = \frac{Qr\mu}{2}$$

The radius rods have to withstand the skidding of the wheels and the tension of the driving chains. The maximum skidding of the wheels $= Q\mu$.

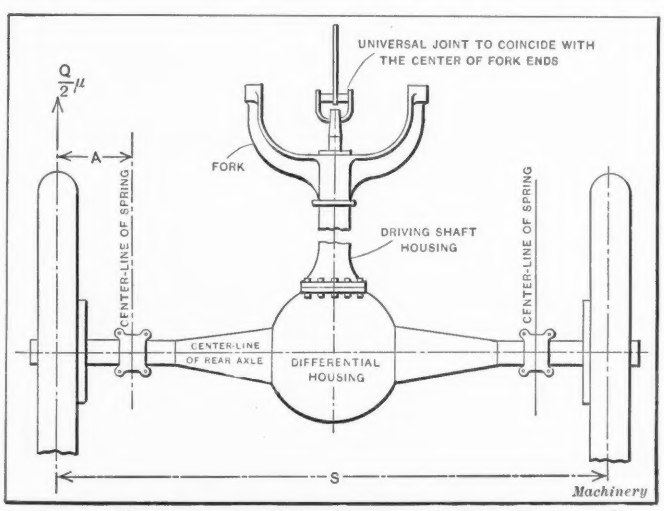

Fig. 4. Diagram for determining Stresses with Shaft Housing and Fork Construction

$$\text{Tension of driving chain} = \frac{\tfrac{1}{2} I T}{\text{Radius of large sprocket}} = \frac{\tfrac{1}{2} i T}{\text{Radius of small sprocket}}$$

The factor of safety for chains should be taken at from 8 to 10, the same as for radius rods. The rear axle should be made out of good nickel steel having a tensile strength of 90,000 pounds per square inch, elastic limit 57,000 pounds per square inch, elongation 19 per cent, reduction of area 53 per cent. The following gives the analysis of a suitable steel for axle construction:

Carbon	0.44
Manganese	0.36
Phosphorus	0.007
Silicon	0.03
Sulphur	0.019
Nicke'	3.33

The rear axle is under the strain of bending on account of the load on the rear wheels and the strains of the radius rods. These factors are:

(1) Moment for one wheel $M_1 = \frac{Q}{2} A_1$

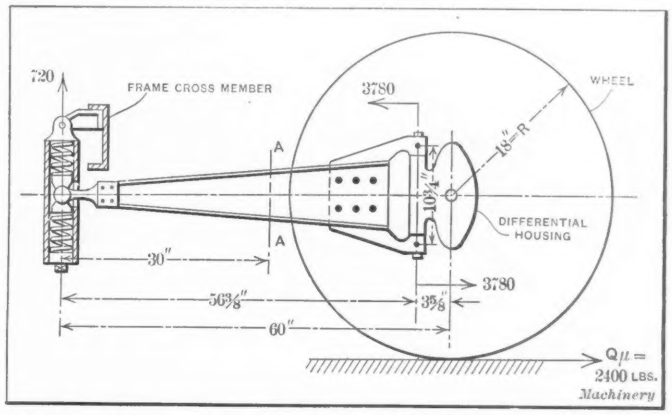

Fig. 5. Diagram illustrating Method of making Torque Rod Calculations

(2) Moment of the radius rod $M_2 = \tfrac{1}{2}$ ($Q\mu$ + tension of the driving chain) A_2.

Resultant bending moment of the axle $M = \sqrt{M_1^2 + M_2^2}$.

Shaft Drive

The live axle is exposed only to a torsional strain TI, but as the axle is parted into halves, each half takes the torque $\frac{TI}{2}$. The factor of safety should be taken at from 7 to 8.

Rear Axle Housing

The housing is exposed to a strain of two bending moments between the two spring seats. These moments are as follows:

(1) Moment of the load of the car $M_1 = \frac{Q}{2} A$.

(2) Moment of skidding $M_2 = \frac{Q}{2} \mu A$.

Resultant bending moment $M = \sqrt{M_1^2 + M_2^2}$.

To be exact, there is also a third bending moment on account of the weight of the differential gears and housing. Let W be the weight of the whole rear axle and suppose that only 0.70 of this weight acts at the center of the axle. Then the bending moment on account of this weight is:

$$M_3 = 0.70\ W \frac{S}{4}$$

Resultant bending moment $M = \sqrt{(M_1 + M_2)^2 + M_3^2}$

We see that the most dangerous section of the axle housing is at the center of the axle. Very often an axle housing is of such construction that the strains of stopping the car when the brakes are applied are transmitted to the housing and from there to the torque rod. In this case, the housing should be strong enough to withstand the braking stresses, that is the torque $Q r \mu$ or TI. The factor of safety of rear axle housing should be from 10 to 12. Torsion $\frac{TI}{2}$

Rear Axle with Driving Shaft Housing and Fork

With the driving shaft housing and fork construction, the strains in the rear axle housing are somewhat greater. With this construction, one universal joint is sufficient. The driving shaft housing is utilized to transmit the shoving force of the axle to the frame and this same member is used for transmitting the torque. The fulcrum of the universal joint has to coincide with the center of the fork on the front end of the construction. The driving shaft housing is subjected to buckling and compression on account of the shoving force and is also subjected to bending on account of the torque of

the motor. There are the following stresses on the axle housing:

$$M_1 = \frac{Q}{2} A.$$

$$M_2 = 0.70\, W \frac{S}{4}$$

Besides these two moments, we have a third moment on account of the shoving force, that is the skidding of the wheels. As with this construction of the axle the springs do not take up the shoving force, this force is taken by the axle housing and we get:

$$M_3 = \frac{Q}{2} \mu \frac{S}{4}.$$

Resultant bending moment $M = \sqrt{(M_1 + M_2)^2 + M_3^2}$.

Torque Rod

The object of the torque rod is to transmit the torsional moment TI from the rear axle housing to the frame. The torque rod is attached near the center of the axle housing, the front end of which is pivoted, with coil springs interposed, to a cross member of the frame. Two universal joints are usually provided with the torque rod construction.

Let the load on rear wheels = 4000 pounds.

Coefficient of friction $\mu = 0.6$.

The torque of the axle is $4000 \times 0.6 \times 18 = 43{,}200$ inch-pounds.

Force ~~Torque~~ of the ball is $\frac{43{,}200}{60} = 720$ pounds.

~~Torque~~ of the housing pin is:

$$-10\tfrac{3}{4} \times F + 720 \times 56\tfrac{3}{8} = 0.$$

$$F = \frac{720 \times 56\tfrac{3}{8}}{10\tfrac{3}{4}} = 3780 \text{ pounds.}$$

where F = force acting on housing pin.

The bending moment of the rod can be easily obtained at any section, and so for instance, the bending moment at section A-A is $720 \times 30 = 21{,}600$ inch-pounds. The problem then consists in designing a coil spring which will not be overstrained when compressed under the load of 720 pounds.

Let P = Load acting upon the spring in pounds;

D = Diameter of spring wire in inches;

R = Mean radius of coil in inches;

K = Allowed stress = 70,000 pounds per square inch;

G = Torsional modulus 10,500,000;

$$P = \frac{\pi D^3}{16} \times \frac{K}{R} = 0.1963 \frac{D^3}{R} K;$$

$$D^3 = \frac{PR}{0.1963\, K};$$

$$D^3 = \frac{720 \times \tfrac{5}{8}}{0.1963 \times 70{,}000} = 0.032;$$

$D = \sqrt[3]{0.032} = 0.33$ inch = about 5/16 inch = thickness of wire.

$$\text{Deflection of one coil} = \frac{64 R^3}{D^4} \times \frac{P}{G} = \frac{4\pi R^2}{D} \times \frac{K}{G}.$$

$$\text{Deflection of one coil} = \frac{4 \times 3.14 \times (\tfrac{5}{8})^2 \times 70{,}000}{0.33 \times 10{,}500{,}000} = 0.099$$

inch.

If there are, for example, ten coils, the deflection of the spring will be $0.104 \times 10 = 1.04$ inch.

The torsional forces become very great when a car is moving on a steep grade, but the maximum stresses occur when the wheels suddenly strike a large obstacle. The resistance to rotation of the wheels then increases rapidly, and the flywheel momentum, adding to the normal torque of the motor, produces a momentary driving effect greater than in regular running. The torque rod must be of proper dimensions to withstand such extraordinary stresses. In respect to the construction of torque rods, designers are of many different minds. Some favor a single tube, others favor two tubes arranged like a V, and still others prefer a tube around the propeller shaft with one universal joint. Many are coming to the use of stamped rods, and this is now considered very good practice.

ECONOMY IN TOOL DESIGN

BY E. H. PRATT*

The production of duplicate parts has developed many interesting features in regard to tool design. One feature which is of considerable importance is the study of tool economy. It is a well-known fact that jigs, tools and special machinery form the basis of all duplicate part systems and that the success of the system is judged largely from an economical standpoint. Many jigs and tools are so designed that even though they produce interchangeable parts accurately their use is prohibited on account of the excessive first cost; or, on the other hand, of the cost of operation. It is necessary,

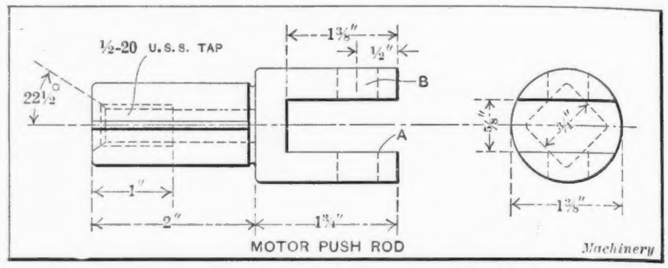

Fig. 1. Valve Push Rod for Automobile Motor

therefore, that the designer should study the problem in hand so that he will be able to design a tool as cheaply as possible which will at the same time be easily operated and produce accurate work. However, it is not always the cheapest tool that is the most economical in the long run, and it is the object of this article to show two extreme cases—one in which the cost was increased and the other decreased.

An Example of False Economy

Having many thousand automobile motor push rods of the type shown in Fig. 1 to machine, considerable time was taken

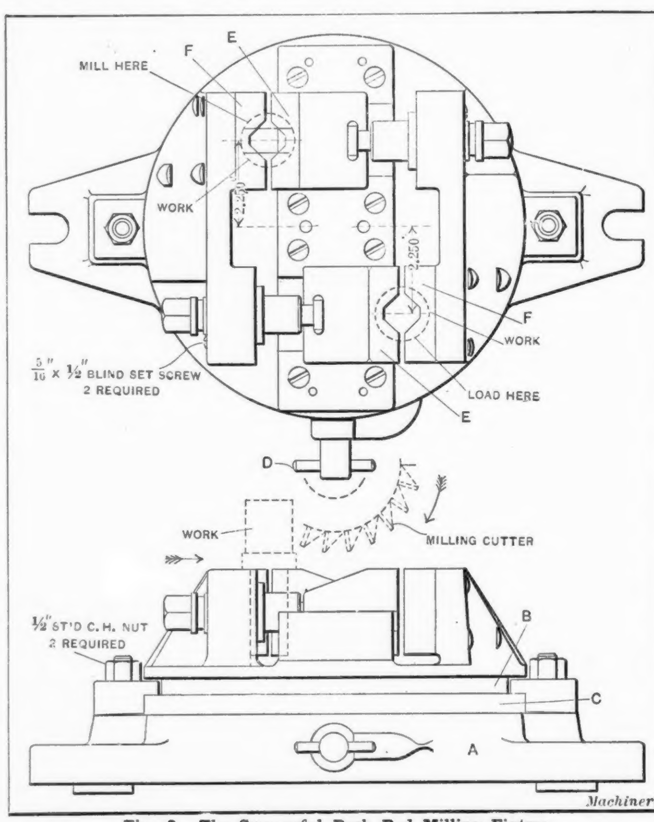

Fig. 2. The Successful Push Rod Milling Fixture

to design jigs and tools to perform the milling and drilling operations. The smallest diameter of these push rods was turned in an automatic screw machine and varied considerably in diameter, which made it necessary to hold them in an adjustable fixture. In turning these push rods in the automatic screw machine a very uneven surface was produced owing to the fact that considerable stock was removed.

The first fixture which was designed for milling the slot A in these push rods, which eventually proved unsuccessful,

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is shown in Fig. 3. This fixture was designed to hold twelve push rods at a time and was made on the indexing principle, so that while one row of push rods was being milled the operator was loading the opposite side. When the milling operation was completed the locking plunger *A* was withdrawn by means of handle *B* and the fixture indexed by hand. This milling fixture was rigidly constructed, and though considerable time was taken in making it accurate it was found impossible to mill two sets of rods and have the slots central.

By referring to Fig. 1 it will be seen that the slot *A* is wide and deep, and the push rod could not be supported at the upper end to withstand the strain of the cut owing to the fact that the large diameter was not concentric with the small end. The construction of the milling fixture, as far as the base is concerned, is of simple design and consists of a casting *C* provided with the usual pivot *D* and a top swinging member *E*. This top casting is formed to the shape shown and is provided with two channels for carrying the V-blocks in which the work is clamped. The milling operation is performed lengthwise of the jig. This fixture would be found suitable for many varieties of work, but for this push rod, which varies considerably in diameter, it was found impossible to mill the slot central with the large diameter, and therefore the fixture was a failure.

In endeavoring to locate the difficulty, it was found that by clamping more than one of the push rods in the jigs at a time the variation in the size of the V-blocks tended to throw the work in different directions. The variation in the size of the V-blocks was only about 0.002 inch—where the blocks fitted in the fixture—but when the lower end of the push rod was thrown out of line, the error was multiplied at the large end where the cutter was working. This not only caused the slot to be out of center, but prevented the succeeding push rods from being clamped tightly enough to hold them rigidly, therefore causing chatter. It was found, however, that by placing one push rod at a time in this fixture the slot could be milled central. This furnished an idea that led to the design of the milling fixture shown in Fig. 2.

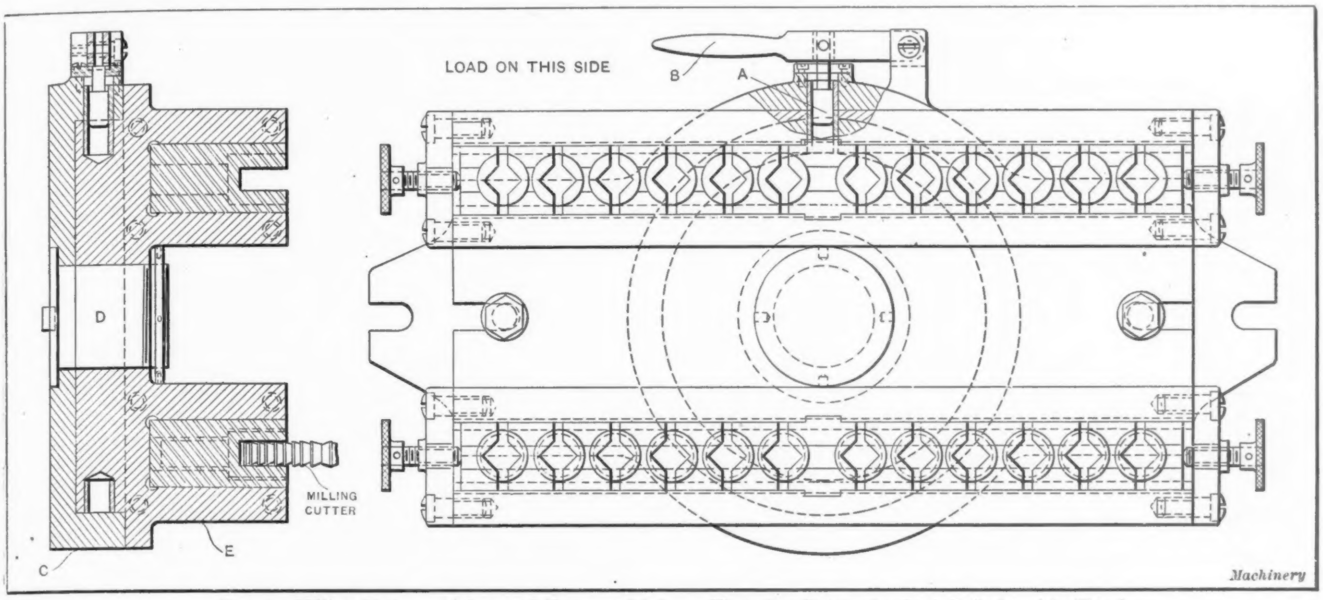


Fig. 3. Milling Fixture which proved Unsuccessful for milling the Slot in the Push Rod shown in Fig. 1

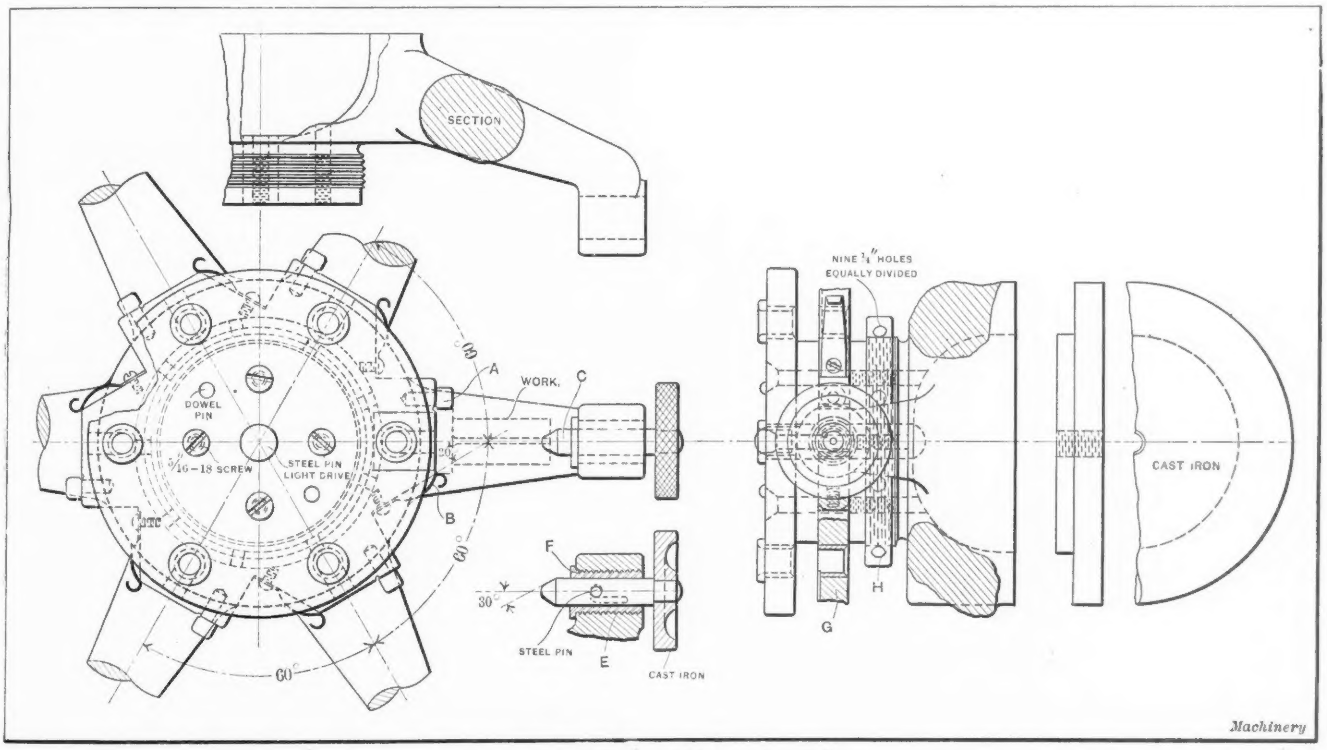


Fig. 4. The Drill Jig which proved a Failure

The Successful Milling Fixture

The fixture which proved successful for milling the slots in the push rods is shown in Fig. 2. This fixture consists of the usual base *A* to which is held the swiveling part of the fixture *B*, this being locked to an index plate *C* by the pin *D*. The index plate *C* is clamped to the base by two toe clamps as

illustrated. The principle on which this milling fixture was designed was to hold only two push rods at a time, so that while the cutter was operating on one the operator could be placing another piece in the opposite vise. The movable jaws *E* were operated independently of each other and were provided with adjustment for wear; and also made strong enough to insure long service. The jaws *E* and *F* were relieved in the center so that they only came in contact on the upper and lower portions of the smallest diameter of the work. This prevented the work from being thrown off center and also held it much more rigidly. The fixture was indexed one-half turn and was locked in position by pin *D* fitting in hardened and ground bushings. This fixture, although somewhat expensive to make, proved an accurate and rapid producer.

The Drilling Jig

By referring to the push rod shown in Fig. 1 it will be seen that a ½-inch hole *B* is drilled through the lugs. The first drilling jig made to handle this work is shown in Fig. 4 and was designed to hold six push rods at a time. This fixture was intended to be used on a multiple spindle drilling machine. The principle upon which this jig was designed was to hold the six push rods as indicated by the heavy dotted lines in Fig. 4. The push rod was held up against a hardened block *A* by a flat spring *B* and a cone-pointed plunger *C* fitting the hole produced in the push rod in a previous operation. This plunger was designed on the quick-acting principle, as shown in section at *E*. A pivot was driven into the rod *C* which worked in an elongated slot in the bushing *F*. The lower face of the slot on the push rod was held up tightly against the bushing plate *G* by a nut *H*. Although this drilling jig is apparently well designed, it was an absolute failure owing to the method of clamping. It also produced inaccurate work and was extremely expensive to make.

The Successful Drilling Jig

The drilling jig which was finally made for drilling these push rods is shown in Fig. 5. It was made from stock castings and consisted of a baseplate *A*, bushing block *B*, locating bar *C* and a hinge clamp *D*. Only three push rods were held in this jig at a time, but two jigs were made and used by the operator. One jig was filled while the other was under the drill press. Only three spindles of a six-spindle multiple spindle drilling machine were used for performing the operation, but this was handled so rapidly that there was no lost time between moves; hence the jig proved to be entirely satisfactory. In this case the largest body of the push rod fits in similarly shaped holes in the jig, being held in place by screws *E* which have compensating caps *F* fitted to them.

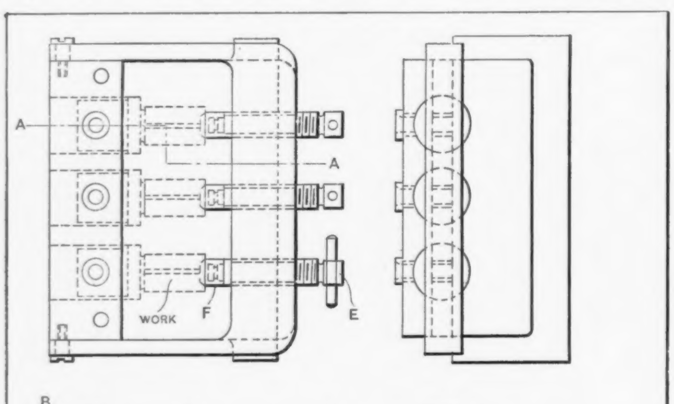


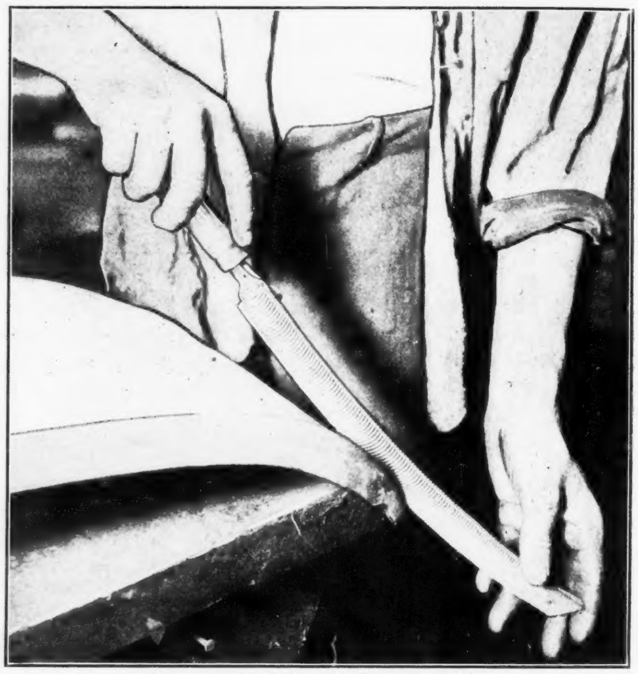
Fig. 5. The Successful Drilling Jig

These examples of jig and tool design show what might be considered true and false economy. The expensive milling fixture and the inexpensive drilling jig for the push rods are tools that might be placed in the true economy class, as they are operated at a minimum of expense and produce accurate results. The first milling fixture that was thought to be technically designed and also the drill jig shown in Fig. 4 are tools that are not economical from a manufacturing standpoint. The conclusion can therefore be drawn that it is not always the simplest nor, on the other hand, is it the most expensive jig that is the most economical, but rather the one that is designed after a very careful study of shop conditions. Too much thought cannot be given to the manufacture of drilling jigs which are to be used by inexperienced workmen.

* * *

USING CURVED FILES ON AUTOMOBILE BODIES

An interesting development in filing has been made by the automobile makers in Detroit and vicinity, who have a great deal of filing to do on sheet metal automobile body sections. A large part of this work is the cleaning up of brazed joints, and for this purpose they find that files curved to a radius of approximately two feet give the best results in getting at the work and in clearing the chips. If an ordinary solid file is used it must be bent while hot, and only one side is available without rebending.



Type of File used on Automobile Bodies

The Vixen File Co., of Philadelphia, Pa., has met the demand for curved files by furnishing a curved base upon which the ordinary straight "Vixen" file blade may be mounted. The steel used in "Vixen" files will stand this bending in a cold state, so that after one side has been worn out it is simply necessary to remove the blade and reverse the bend. The accompanying illustration shows a file and its application to the work. C. L. L.

* * *

The war in the Balkans, aside from attracting the attention of the world in general, has had a direct effect upon the machine trade in the curtailing of the emery supply. The best emery in the world comes from the island of Naxos, a Greek possession, and from this island and Asia Minor are mined the bulk of the world's emery. When the war broke out, the emery miners dropped their picks and shovels to take up their rifles and the emery supply was practically cut off. As a consequence, emery wheel manufacturers are devoting more attention to artificial abrasives, especially as a rise in the price of Greek emery is anticipated when the supply is resumed. The mining and exportation of the Naxos emery is under the direct control of the Greek government.

* * *

Some one has said that much valuable energy is wasted in preserving secrecy. Inefficiency and secrecy in a manufacturing plant are twins, and go hand-in-hand.

MAKING MOTOR POPPET VALVES

ELECTRIC WELDING, AUTOGENOUS WELDING AND MACHINING OPERATIONS

BY DOUGLAS T. HAMILTON*

The poppet type of valve generally used in gas engine construction is one of the parts which requires more attention and care in its manufacture than is usually recognized. It is absolutely necessary that the head or valve disk form a perfect bearing in the valve seat, not only to economize in fuel, but also to provide for a quiet and smooth running engine. The valve heads are necessarily subjected to the high temperatures of the burning gases and therefore should be made so that they will resist warping. They also should be made from a material which will resist the tendency to burn or oxidize, which results in a leaky valve. To overcome the rapid deterioration of engine poppet valves, many attempts have been made to secure a material that will give a long life. Among the materials which have been tried with more or less satisfactory results are vanadium steel, nickel steel and cast iron. The disadvantage of making a valve head from cast iron is that it breaks off easily, and, although the bearing obtained is satisfactory, the life of the valve is short, owing to the corners breaking off. Several attempts have been made to secure a cast-iron head to the stem by riveting, but the results have not been entirely satisfactory. Another method which has been tried is to fasten a cast-iron ring to a nickel steel drop-forged head, but this has proved unsuccessful, owing to the ring's breaking, even though electrically welded. In the following article is described a method which consists in depositing a high silicon cast iron on the seat of the valve head by autogenous welding.

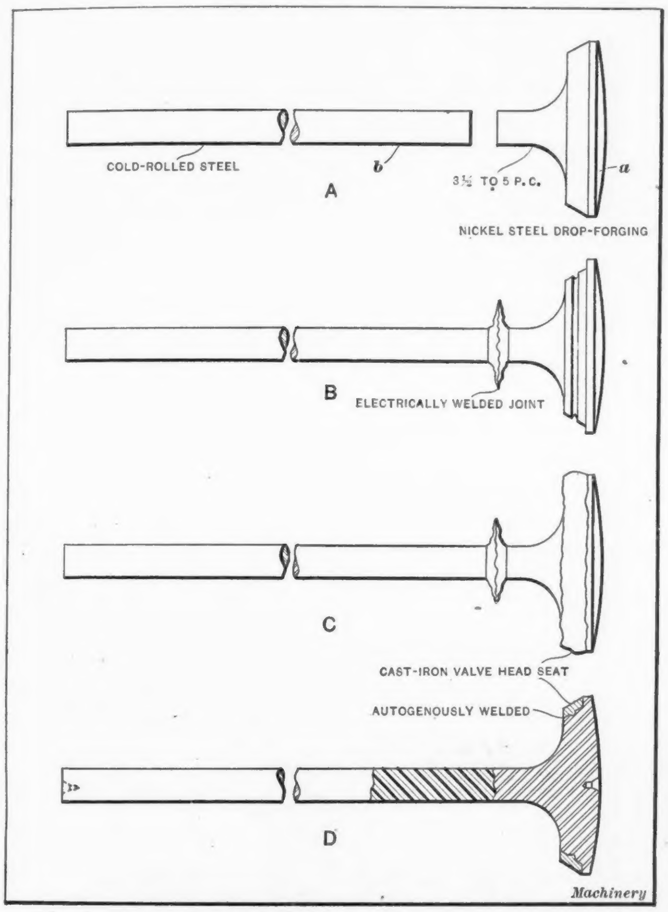


Fig. 1. Various Stages of Manufacture through which an Improved Poppet Valve passes

Preliminary Machining and Electric Welding Operations on Poppet Valves

As indicated in Fig. 1, a poppet valve consists of two parts, *viz.*, a head *a* and a stem *b*. As a rule, the head is made from a nickel steel drop-forging, containing from 3½ to 5 per cent nickel. The stem is made from a piece of cold-rolled steel, generally 25/64 inch in diameter, and long enough to meet the requirements of the engine in which it is to be used. After the drop-forging has been made and the cold-rolled stock has been cut off to the required length, these two members are welded together in an electric welder of the type shown in Fig. 2.

In operation, the head is clamped between copper jaws *A* and the stem held in a similar manner by the jaws *B*, the two ends of the work being butted together. The copper jaws are now brought down tightly on the work by means of a foot lever. The electric switch attached to the lever which the operator grips with his right hand, is then closed, turning on the current and immediately heating the ends of the work. When the proper temperature is reached—almost a white heat—the two pieces are brought together by means of the lever *C*, which the operator controls with his right hand, and as the metal is in a semi-fluid condition the pressure exerted on the lever joins the two ends, forming a homogeneous mass and a perfect weld. Forcing the work together in this manner when in a highly heated state, forms a flash at the joint, as indicated at *B* in Fig. 1, which is removed in a subsequent operation. For welding this particular valve stem, two legs of a three-phase 440-volt current are used, which through a transformer in the machine is cut down to five volts. The welded stems are turned out at the rate of 2500 per day of nine hours.

Fig. 2. Electrically-welding Poppet Valve Heads to Stems in a Toledo Electric Welder

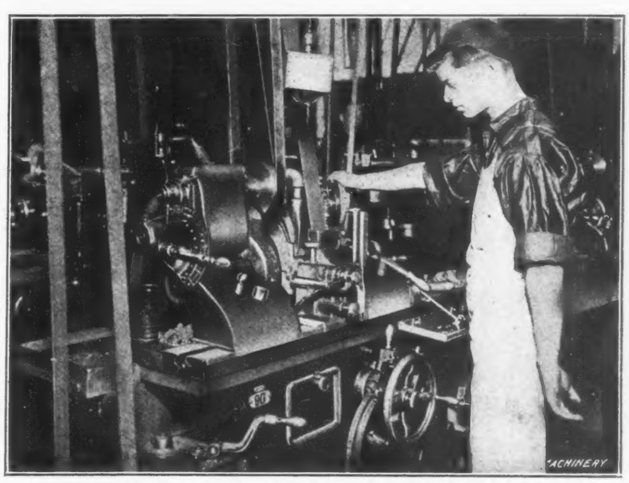


Fig. 3. Grinding Poppet Valve Stems in a Landis Plain Grinding Machine

After electric welding, the stem is cut off to the required length and both ends of the valve are centered; then the head is machined, a roughing and finishing cut being taken, and at the same time a small groove is cut in the seat, as indicated at *B* in Fig. 1. The next operation is to remove the burr or flash left by the welding operation in a hand screw machine.

* Associate Editor of MACHINERY.

Depositing Cast Iron on the Valve Seat by Autogenous Welding

What might really be considered the most interesting operation in the manufacture of this poppet valve is the building up of a seat on the head by means of what might properly be termed a "putting-on tool," the cast iron being deposited by means of an autogenous torch. To accomplish this operation, the valve is placed on the fixture *A*, Fig. 6, resting on its head.

Fig. 4. Group of Autogenous Welding Operators at Work on Motor Poppet Valves

This fixture is rotated by means of a foot treadle, thus enabling the operator to deposit the cast iron evenly around the surface of the seat of the valve head. The cast iron, before being deposited, is in the form of a rod ¼ inch in diameter, and is made from a grade of cast iron containing a high percentage of silicon—from 5 to 10 per cent. It has been found after many experiments that this grade of iron gives unusually satisfactory results for autogenous welding. The bar *B* is melted by the autogenous torch *C*, which develops a heat of about 6300 degrees F. It requires only a very short time for the operator to deposit the required amount of cast iron, when the valve is removed from the fixture and placed in the lime on the bench to cool, as indicated at *D* in Fig. 6.

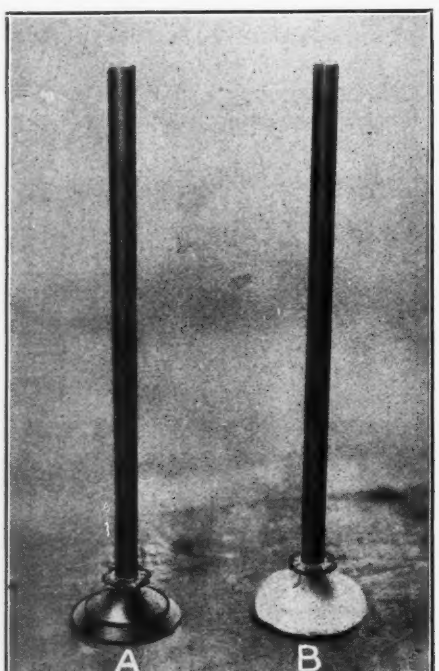


Fig. 5. Poppet Valve before and after applying the Cast Iron by Autogenous Welding

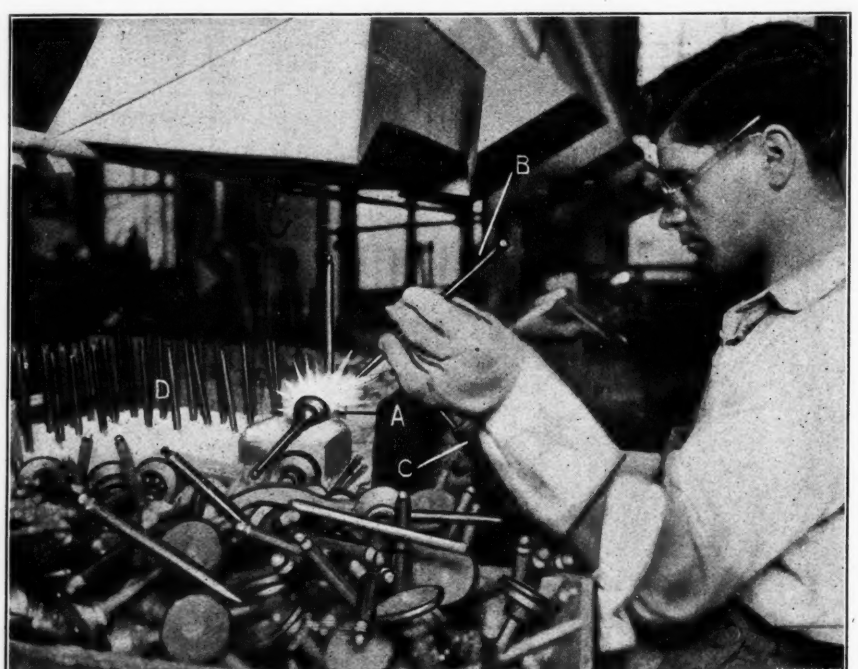


Fig. 6. Close View of Welder at work applying Cast Iron to Poppet Valve Heads by Autogenous Welding

Fig. 4 shows a group of operators at work in the plant of the Metals Welding Co., Cleveland, where this information was obtained. The condition of the valve heads before and after depositing the cast iron is shown at *A* and *B* in Fig. 5, and also at *B* and *C* in Fig. 1. After the valve has cooled, it is taken to a hand screw machine and a light cut removed from that portion on which the cast iron was deposited. This operation is performed to determine whether or not there are any defects in the seat, due to the metal not running freely, and thus causing blowholes or cold shuts.

Final Machining Operations

The roughed valves are now taken to a hand screw machine and the cast-iron seat is machined. After machining, the valves are taken to the grinding machine shown in Fig. 3, where the valve seat is ground to the required angle and diameter, after which the stem is ground to ⅜ inch diameter, a limit of 0.0005 inch being allowed on a stem 7 inches in length. The lower end of the stem is casehardened and upon the completion of this operation the valve is ready for use.

It will be seen from the foregoing that although a poppet valve seems to be rather simple in construction, it requires the most painstaking care in its production, and its life depends largely on the proper execution of the various operations outlined. At *D* in Fig. 1 is shown a poppet valve completed and ready for use on a gas engine, with the exception of the cutting of the slot in the head which is used for driving the valve when grinding in the seat; this illustration also shows clearly the three materials used in its make-up.

* * *

The General Electric Co. has brought out a new incandescent lamp which is said to use only one-half as much current for the same candlepower as the present tungsten lamps. The new lamp contains a specially shaped tungsten filament surrounded by an inert gas like nitrogen at atmospheric pressure. The gain in efficiency of incandescent lighting thus made within the past six years, is about sixfold, the present tungsten lamps requiring only about one-third as much current as the common carbon filament lamp for the same lighting effect.

METHODS USED IN MANUFACTURING THE JONES SPEEDOMETER

MAKING THE PARTS, ASSEMBLING AND TESTING FINISHED INSTRUMENTS

BY EDWARD K. HAMMOND*

Few automobile accessories add more to the interest derived from driving an automobile than the speedometer, for this instrument affords a constant indication of the speed at which the machine is traveling, a record of the distance covered on each individual trip and the total number of miles traveled during the season. Various forms of mechanism have been employed for actuating the different types of speedometers on the market. In the Jones speedometer, with which this article is concerned, the mechanism is controlled by centrifugal force. When a body is rotating about a fixed center, a tendency is developed for the material to fly off at a tangent. The magnitude of centrifugal force is expressed by the following equation:

$$F = \frac{WV^2}{GR} = \frac{WRN^2}{2933.9}$$

where

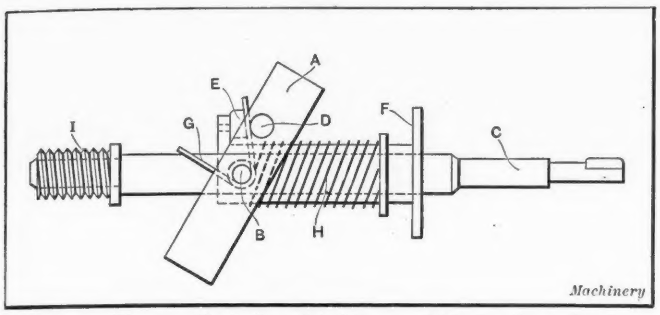


Fig. 1. Diagram illustrating Principle on which the Jones Speedometer operates

V = linear velocity of center of gravity of rotating body in feet per second $= \frac{2\pi RN}{60}$;

G = acceleration of gravity = 32.17;

N=R.P.M. of rotating body;

W = weight of rotating body in pounds;

R = radius in feet.

Fig. 1 shows the mechanism which actuates the Jones speedometer. A flexible shaft connects the instrument to a gear, secured to the inside of the hub of one of the front wheels. (One of these gears is shown in Fig. 2.) Hence, the speed at which the car is traveling controls the speed of rotation transmitted to the instrument. Referring to Fig. 1, A is the governor or rotating member, the centrifugal force of which actuates the speed indicator. This governor is pivoted at the point B. The spindle C is connected to the wheel of the car by means of the flexible shaft previously referred to. It will be evident that as the spindle C revolves, centrifugal force gives the governor A a tendency to rotate about the pivot B toward a position where its plane will be perpendicular to the spindle C. This tendency is resisted by the saddle spring G, which bears against the pin D in the governor. The tension of the saddle spring is so regulated that the position of the governor causes the needle of the speedometer to indicate the speed at which the car is traveling. The manner in which this result is obtained is as follows:

Fig. 2. Gear on Front Wheel of the Car, which drives the Speedometer

As the governor A moves toward the vertical position, the pin D, which engages with the finger E, draws the governor disk F forward. The governor disk is in contact with a small fiber roller at the end of a bell-crank. As the disk is drawn forward, the bell-crank revolves on its pivot and causes the indicating needle to move over the scale on the speedometer dial, thus showing the rate at which the car is traveling. The spiral spring H returns the disk toward the zero point when the speed of the car is retarded.

Making the Speedometer Parts

In the present article the purpose is to describe a number of interesting methods of instrument making employed in the factory of Jones Speedometer, New Rochelle, N. Y. Fig. 3 shows several of the parts, which will be referred to later in connection with the methods used in making or assembling them. The speedometer spindle is shown at C in Fig. 3. These spindles are roughed out from machine steel, the op-

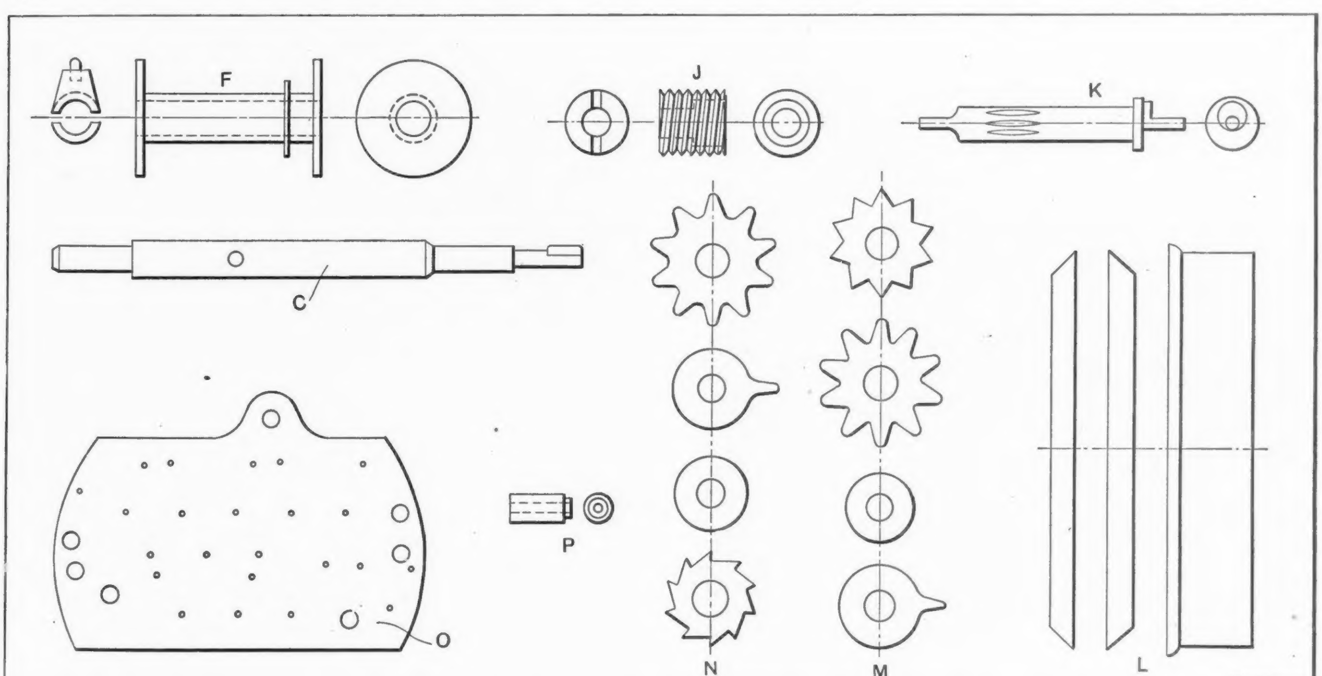


Fig. 3. Some Parts of the Jones Speedometer

*Associate Editor of MACHINERY.

eration being in accordance with standard practice. The next step is to form the key at the right-hand end of the spindle which engages with the coupling on the flexible shaft. This key is swaged on the shaft by the punch and die illustrated in Fig. 4. The end of the spindle which is to be swaged is inserted in the hole E in the die. When the press is tripped, the pins A are forced down by means of the hardened steel studs A_1, carried by the punch. The tapered ends of the pins A force the swaging punches B in against the work and form the key on the spindle. The top of the key is given the required shape by means of the pin C. This pin is forced down by means of the cam D, which is actuated by a hand lever. The position of the pin controls the height to which the metal can flow during the swaging operation. The punches B and pin C are returned by spiral springs when the ram of the press rises.

After the spindles have been roughed out and swaged, they are taken to the hardening department where they are hard-

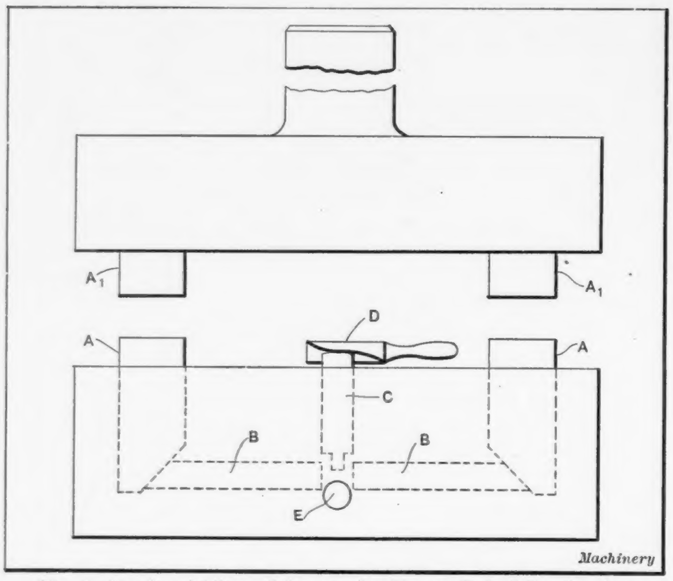


Fig. 4. Punch and Die used for swaging Key on End of Speedometer Spindle

ened locally at the points where the cone bearings are to be ground in a subsequent operation. Upon the completion of the hardening process the hole is drilled in the spindle to receive the pivot B, upon which the governor is carried. The work is then taken to a Sloan & Chace bench lathe, equipped with a compound rest upon which the grinding attachment is mounted. The work is carried in an ordinary draw-in chuck and the bearing cones are ground at an angle of forty-five degrees. After this the work is taken to the Brown & Sharpe

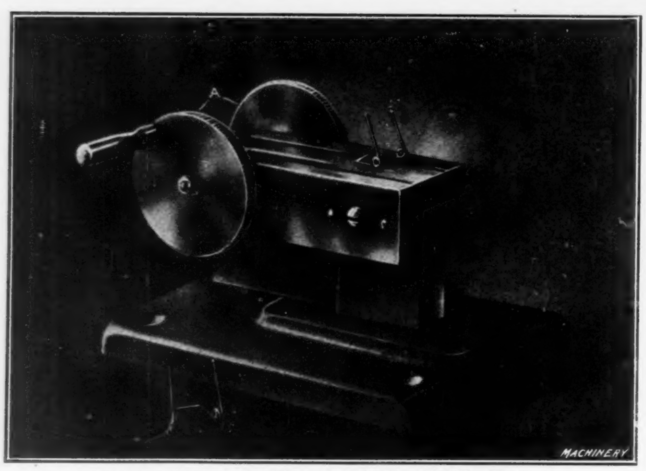


Fig. 5. Special Machine for winding Saddle Springs

universal grinders where the body of the spindle is ground.

The governor disk F is shown in detail in Fig. 3. These disks are made on Brown & Sharpe automatic screw machines, the only unusual point in this company's practice being the method of tooling the machines. It is necessary for these pieces to be finished to a high degree of accuracy, and experience has shown that better results are obtained by mounting the forming tool on the front slide and the cut-off tool on the rear slide, although this is at variance with the standard practice. The drill and reamer for machining the hole through the center of the governor disk are carried in the turret of the "automatic" in the usual way. After the governor disks have been cut off on the screw machine, they are taken to the punch press department where one end of the disk is finished in a die to the form shown in the end view

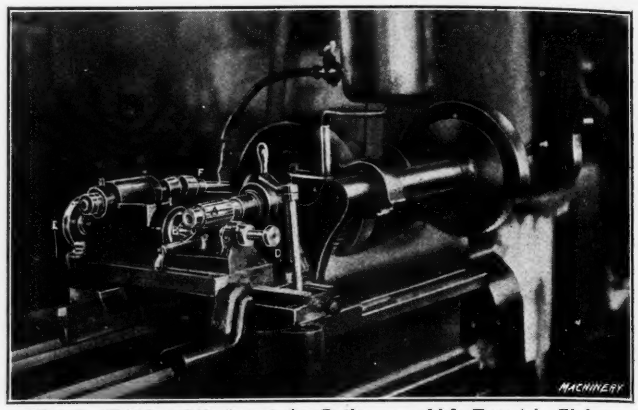


Fig. 6. Hobbing Attachment for Lathe, on which Eccentric Pinions are hobbed

to the left. The body of the spindle and the hole in the governor disk through which it slides have to be finished within a limit of 0.0001 inch, as the least shake between these two members would be detrimental to the operation of the instrument.

Fig. 5 shows a special machine which was designed for producing the saddle springs shown at G in Fig. 1. These springs are made of piano wire, which is cut off to blanks of the required length and bent to form the U-shaped end of the saddle spring by means of a suitable punch and die. The work is then brought to the machine shown in Fig. 5. This machine grips the end of the saddle spring and two coils are wound

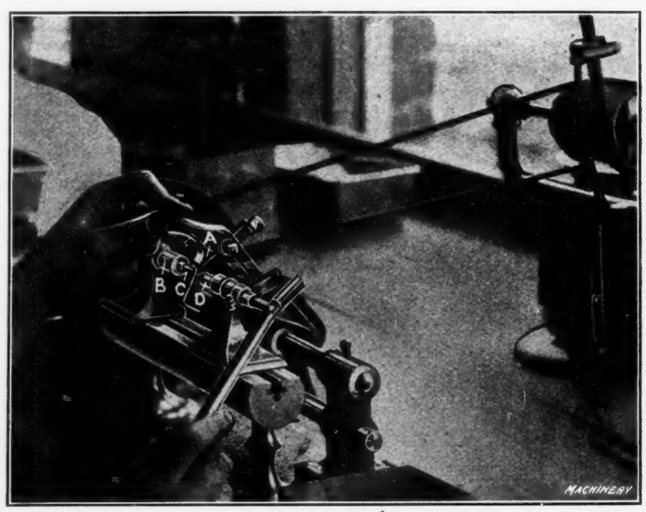


Fig. 7. Bench Lathe with Special Chasing Attachment for turning Bushings

around the mandrel by means of the handles on the index wheels. In operation, the two index wheels A are set at zero; the blank is then placed in the machine and both disks are turned through two revolutions, which brings them back to the index points. In this way the springs are turned out with the ends in exactly the same plane, the work being finished so perfectly that little if any adjustment is necessary before the springs are ready to be assembled in the instrument.

The speedometer mechanism illustrated in Fig. 1 is carried in ball bearings of the cone and cup type. The bearing cups used for this purpose are illustrated in detail at J in Fig. 3. These cups are made on either Brown & Sharpe or Acme automatic screw machines. After being hardened, the bearing cups are ground on a Rivett grinder.

Making the Odometer Parts

It has already been mentioned that the Jones speedometer is equipped with an odometer which indicates both the dis-

tance traveled on individual trips and the total distance traveled by the car during an entire season. A number of different styles of instruments are made, some of which are arranged to indicate a season mileage of 100,000 miles, while others provide only for 10,000 miles. All types of instruments are arranged to indicate individual trips, up to 100 miles in length. A "reset" button is provided at the side of the instrument, and by pushing this button the dials which

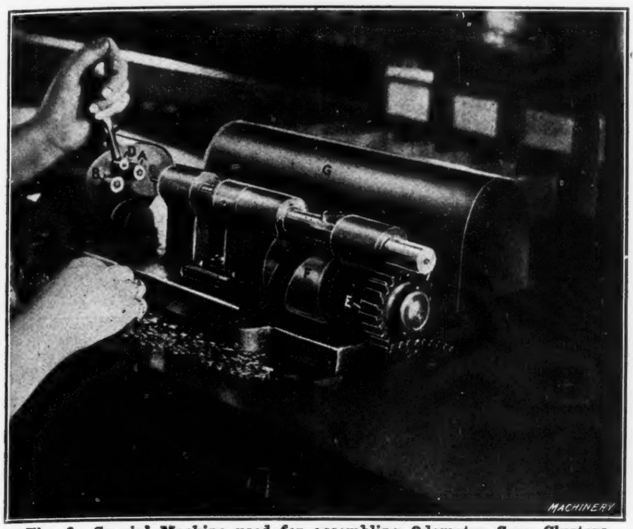


Fig. 8. Special Machine used for assembling Odometer Gear Clusters

indicate the distance traveled during individual trips are instantly returned to zero.

Motion is transmitted to the odometer by means of the worm *I* on the speedometer spindle, as shown in Fig. 1. This worm engages with teeth machined in a vertical "eccentric pinion," which is shown in detail at *K* in Fig. 3. As the speedometer spindle revolves the small eccentric at the end of the eccentric pinion operates a pawl which transmits motion to the trains of gears which turn the dials of the odometer.

The gears which actuate the odometer are arranged in clusters assembled on bushings *P*, Fig. 3. Each of the gears

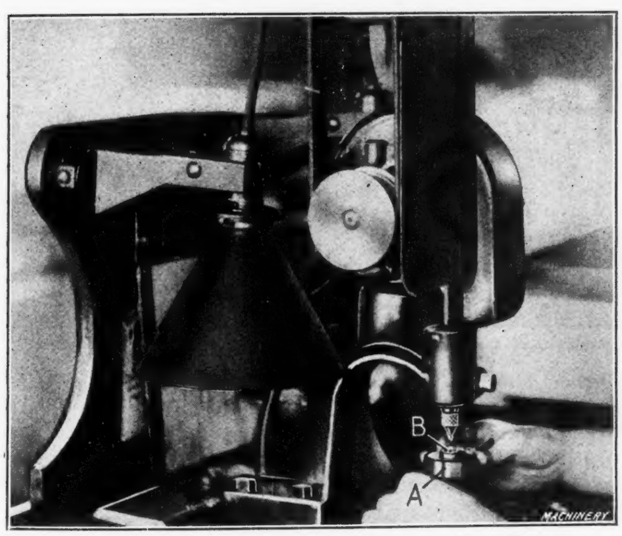


Fig. 9. Riveting the Odometer Dials onto the Gear Clusters

in these clusters has ten teeth and a dial graduated from zero to nine is mounted at the top of the cluster. The gearing is arranged in such a way that the dial at the right-hand end makes one complete revolution. At this point, a pawl of the type shown at the bottom of the series *M* in Fig. 3, engages with a gear of the next cluster to the left and moves it through one space, *i.e.*, one-tenth revolution. After this operation has been repeated ten times, a pawl on the second cluster of gears engages with a gear of the third cluster and moves it through one space. It will be obvious to the reader that the distances indicated by the successive dials to the left have ten times the value of the distance indicated by the dial to the right. Consequently the figures brought into view by the action of this train of gearing indicate the number of miles which the car has traveled.

The blanks from which the eccentric pinions *K* are made are formed in Brown & Sharpe automatic screw machines. After the forming operation has been completed, the work is transferred to a machine equipped with a magazine and feeding chute which delivers it to an eccentric chuck in which the work is held while the eccentric is turned. Fig. 6 shows a very simple form of hobbing attachment for an engine lathe, which is used to hob the teeth on the eccentric pinions. It will be seen that the hob *A* is carried on an arbor held in the lathe spindle. The work is held in the collet *B* and supported at its outer end by means of a tailstock *C*, in which the end of the eccentric pinion fits. The tailstock and collet are adjusted by means of the wheels *D* and *E*, respectively. The work is rotated by means of a universal-jointed rod *F*,

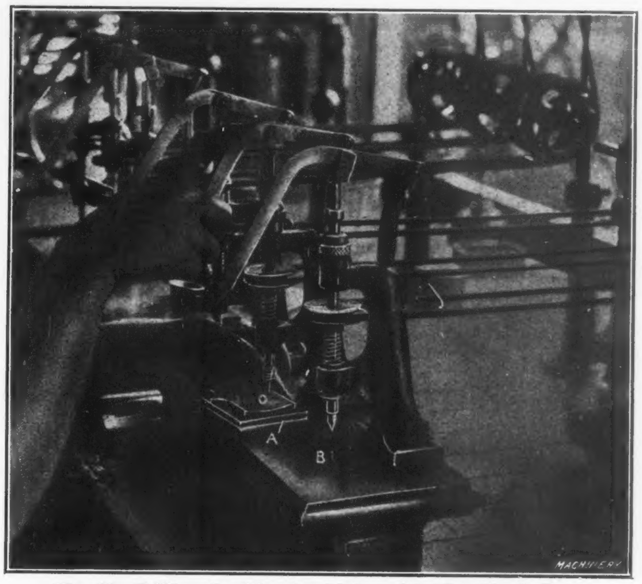


Fig. 10. Drilling the Odometer Plates with "Depthing" Gages

which is geared to the lathe and transmits motion to the collet through a worm and worm-wheel enclosed in the fixture.

The different forms of gears used to actuate the odometer are stamped out from brass ribbon stock. In order to have the work assembled properly, it is obviously necessary for the hole in each gear to be exactly at the center. Compound sub-press dies are used for this purpose, of the type generally used in watch, clock and instrument work. The small bushings on which the gear clusters are mounted are produced on an automatic screw machine. This work is fairly accurate, but there is always some doubt as to the parallelism of the hole with the outside of the bushing. In order to guard against errors from this source, the bushings made on the

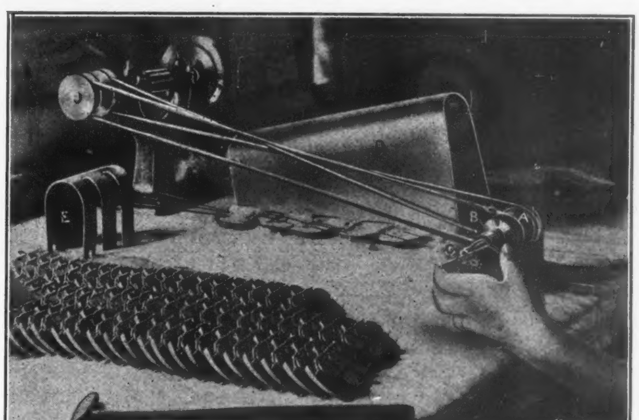


Fig. 11. Special Machine for winding Springs into the Odometer

automatic screw machine are transferred to the bench lathe shown in Fig. 7. This lathe has been equipped with a special chasing attachment. The bushings are carried on a small mandrel in the lathe spindle, which just fits the hole in the bushing, and the outside is turned by means of a tool carried in the chasing attachment. In this way, the hole is sure to

be parallel with the outside of the bushing. The design of the mechanism will be readily understood by referring to the illustration. *A* is the guide on the chasing attachment which fits over the guide bar *B*, carried in the lathe spindle. The parts *A* and *B* are hardened, ground and lapped, and any slight wear which may occur is compensated for automatically. The bushing to be turned is mounted on the small mandrel *C*, and the tail center *D* is pushed up against its outer end by means of the hand lever, thus providing the necessary drive. The mandrel on which the work is carried is ground after the fixture has been set up on the lathe, so that it is sure to be in proper alignment. At intervals, the operator measures the size of the pieces turned on this lathe with a micrometer, and three or four times a day she refers the work to the foreman of the department in order that he may have an opportunity of checking the accuracy of the parts.

Assembling the Gear Clusters

The finished bushings and gears are taken to the assembling department where the gear clusters are assembled on the special machine shown in Fig. 8. This machine consists of a horizontal press, equipped with dies to fit the different gears which constitute the cluster being assembled. Taking as an example the series shown at *N* in Fig. 3, the two upper gears are fitted in the dies *A* and *B*, and a bushing is then placed in the die at the end of the horizontal spindle *C*. The machine is operated by a foot-treadle which turns the cam *F* through the gears *E*. When the treadle is pushed forward, the spindle *C* moves over and forces the bushing into the hole in the gear carried in the die *A*. The index *D* is then set to bring the die *B* in alignment with the spindle, after which the foot-treadle is pressed a second time to push the bushing into the hole in the gear in die *B*. The relative positions of the dies are such that the different gears constituting the cluster are assembled in the proper position in relation to each other. The mechanism is enclosed by the guard *G*, which was removed to show the mechanism.

After the gear clusters have been assembled, they are transferred to an H. P. Townsend riveting machine, shown in Fig. 9, where the dials are riveted onto the top of the clusters. The riveting machines used for this purpose are fitted with "nests" *A*, which are virtually small dies in which the teeth of the different gears in the cluster fit. In order to locate the dial in the proper relation to the gears in the cluster, a gage *B* is provided. This gage is merely a leaf hinged to the fixture and provided with three holes through which three numerals on the dial can be seen. After the cluster has been placed in the fixture, the dial is so set that the proper figures show through the holes in the gage. The riveting machine is then brought into action, riveting the end of the bushing down over the edge of the hole in the dial.

Drilling the Odometer Plates

The different parts of the odometer mechanism are assembled on a brass plate of the form shown at *O* in Fig. 3. It will be seen that there are thirty holes which have to be drilled in these plates. In order to do this work with the greatest possible dispatch, the method of drilling by means of a "depthing" plate has been adopted. This is another method which is in quite general use in instrument making and combines the benefits of rapid production with a high degree of accuracy. The six large holes in the odometer plate have been drilled before the work comes to the battery of Stark bench drills, shown in Fig. 10, and two of these holes are utilized for locating the work on the depthing plate *A*. The pin *B* on the table of the bench drill is in exact alignment with the spindle. This pin fits into holes on the under side of the depthing plate and brings the work into the required position for drilling the different holes. The girls who operate these machines sit on stools which run on rails in front of the bench. After the holes have been spotted, the operator moves over to the next machine in which holes of one size are drilled; she then moves on as necessary, in order to get in position to drill and ream the different sizes of holes in the odometer plates.

It has already been mentioned that an instantaneous "reset" device is provided for use in connection with the part of the odometer which indicates the distance traveled on individual trips. This reset device is operated by pushing a small button on the side of the instrument. Each of the three dials in this part of the odometer works against the tension of springs, being held in the position to which they are moved

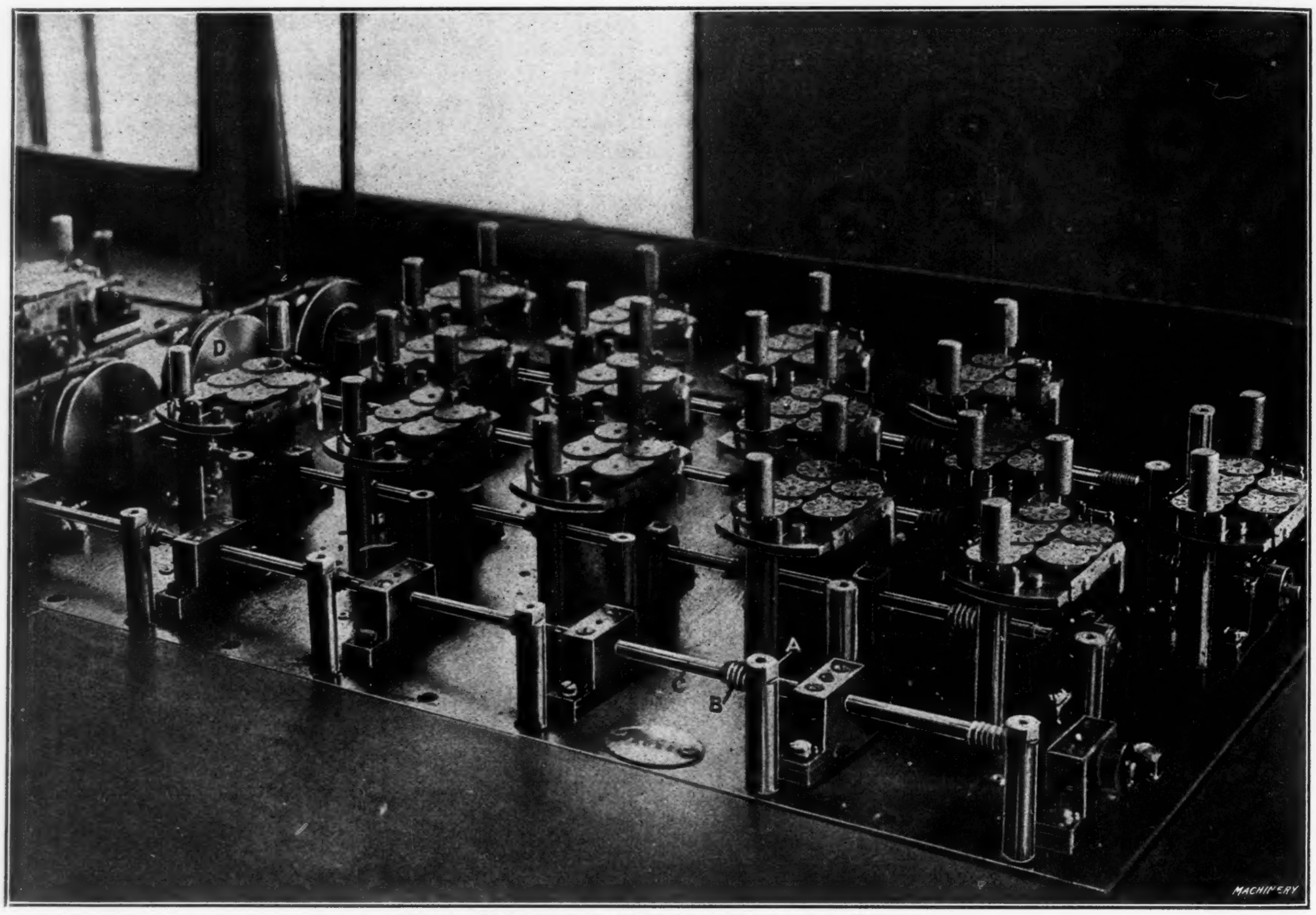


Fig. 12. Method used in testing the Accuracy of the Odometer

by means of suitable ratchets and pawls. When the reset button is pushed in, it releases the pawls and consequently allows the dials to be returned to the zero position. The springs which actuate the reset device are wound on the lower end of the bushings on which the gears and dials of the trip mileage odometer are assembled. There are three clusters of gears in the train and it will be evident that as two of these clusters rotate right-hand, the third (or intermediate) cluster rotates left-hand. Hence, it is necessary to wind two of the springs right-hand and the third spring left-hand. Fig. 11 shows a special machine which was developed for use in winding these springs. It consists of a spindle *C*, provided with a suitable clutch mechanism for engaging a small washer at the end of the sleeve on which the spring is to be wound. It will be noted that two belts run from the countershaft to the machine, one being open and the other crossed. There are two foot treadles under the bench, and by pushing one of these treadles the friction clutch *A* is engaged to drive the arbor through the crossed belt which winds the right-hand springs. By pushing the other treadle, the opposite side of the clutch is engaged with the cone *B* and the machine drives through the open belt, thus winding the left-hand springs. The belts and clutch are ordinarily enclosed by the guards *D* and *E*.

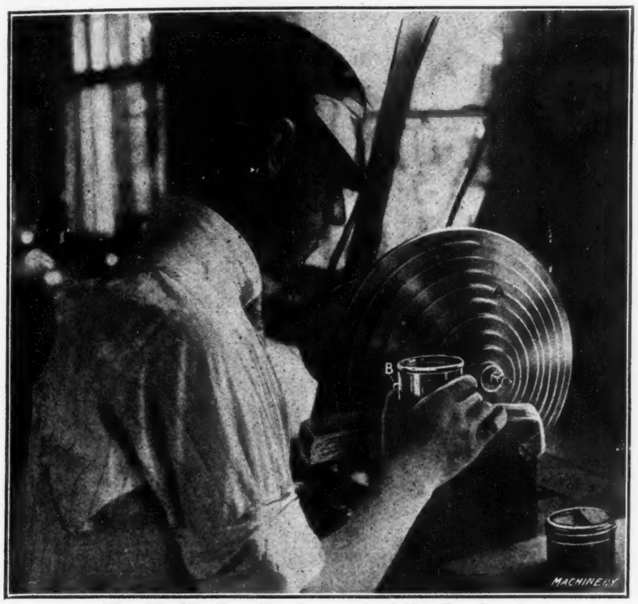


Fig. 13. Testing the Accuracy of the Speedometer

The springs consist of flat strips of bronze which are attached to the bushing at one end and are wound up by means of the frictional contact of the opposite end with the case in which the spring is contained. For a length of one inch at the free end, the spring is approximately double the thickness of the remaining section. These springs are rolled from bronze wire on a W. W. Oliver rolling mill equipped with a special form of rolls. These rolls are of such a size that a spring is produced at each revolution. The rolls are ground away slightly for a distance of one inch on their circumferences. This reduction leaves the necessary "thick spot" on the end of each spring. The wire from which the springs are rolled is fed into the mill from a reel, and the springs are rewound from the mill onto a second reel. They are then cut up, as required, for use in the assembling department.

The speedometer mechanism is enclosed in a brass case which consists of two parts. The lower part is a deep cup, while the upper part or cover is a sleeve in which a bevel glass is mounted. The method of setting the mechanism in the sleeve is quite interesting. It is obviously necessary for this joint to be both dust- and water-proof in order to protect the mechanism from injury. The method by which this is accomplished consists of first mounting the sleeve upon an expanding chuck. The nickel-plated "bezel" plate which goes under the glass is next placed in position, after which the plate of bevel glass is put in place and the brass cylinder is spun down over its edge. A very neat looking job is produced in this way, and the joint is tight enough to make it absolutely water-proof. The glass, bezel plate and sleeve are shown at *L* in Fig. 3.

Testing the Finished Instruments

The work produced in each department of the factory is subjected to strict inspection before being sent on to the assembling department. After the odometers have been completed, they are set up on testing stands of the type shown in Fig. 12. It will be seen that these stands consist of rows of vertical studs *A* on which the odometers are clamped by means of knurled-headed screws. The eccentric pinions which mesh with the worms on the speedometer spindle in the finished instrument engage with worms *B* on the horizontal shafts *C*. These shafts are driven by belts running over the pulleys *D*. The odometers are tested first at a speed of 125 miles an hour and then at a speed of 10 miles an hour. As the instruments are started from the zero point, their indications should all coincide at any period of the test. Any instrument which shows an error of as much as one-tenth mile an hour is sent back to the assembling department and adjusted until it will endure the test satisfactorily.

After the odometers have been tested as described, the entire instrument is assembled and then tested on machines of the type shown in Fig. 13. It will be seen that this machine consists of a fourteen-step cone *A*, and the speedometers to be tested are driven by means of a rubber pulley *B*, which is temporarily mounted on its spindle and engaged with the different steps on the cone. In this way, speeds of from 2 to 100 miles per hour are available. These tests are conducted for two purposes: First, to see that the instrument indicates accurately when running at the different speeds which are produced by successive steps on the testing cone; second, to make sure that the instrument runs steadily. When any error is discovered, it is usually due to imperfection in the saddle spring or else to improper adjustment of the ball bearings in which the spindle runs. The latter is the most frequent source of error, and the first step taken to remedy it is to adjust the bearings slightly. If this does not give the required result, the instrument is taken apart and the saddle spring adjusted or replaced as may seem advisable. It is the extreme care taken in producing each part of these instruments and testing them which has won a favorable reputation for the Jones speedometer in automobile circles.

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ETCHING ON BRASS AND STEEL

BY WALTER H. STICKLER*

In the How and Why section of the August number of MACHINERY a request was made for information on the subject of etching. For etching on brass a satisfactory ground can be made from equal parts of beeswax, burgundy pitch and asphaltum. These constituents are melted together and thoroughly stirred in order to secure a uniform mixture. This ground is warmed before using and spread evenly over the surface that is to be etched. After the ground has had time to cool, it is removed from those sections of the metal that are to be etched, after which the etching fluid is applied. A satisfactory etching fluid consists of one part of nitric acid to four parts of water. After the "biting" has been completed, which takes only a few minutes, the work is dipped in hot water to wash off the acid. The surface of the work can then be cleaned by wiping it with a cloth dipped in benzine or gasoline.

For etching steel the ground is also made of equal parts of beeswax, burgundy pitch and asphaltum. This ground is applied to the work according to the instructions given for application on brass pieces. The etching solution used for steel consists of

Pyroligneous acid	4 ounces
Alcohol	1 ounce
Nitric acid	1 ounce

As soon as the biting operation is completed the work is dipped in hot water to wash off the biting solution, after which the work is cleaned with gasoline or benzine, as in the case of etching operations on brass. In order to obtain satisfactory results it is important to have the work perfectly clean before the ground is applied.

* * *

A man is not a genius simply because he does something that is odd but not particularly useful.

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THE ADVANTAGES OF CAST-IRON GEARS

BY EDGAR H. TRICK*

There is more to be known about gears than most people think. All engineers and designers of machinery, and many users of gears know a lot about the theory of gears—systems of tooth development, involute and epicycloidal teeth, etc.; but, getting down to brass tacks, as the saying is, how many know just exactly wherein lies the superiority of one gear over another? The two principal sources from which this excellence may come are the material from which the gear is made and the process by which it is made.

General purpose gears are made from cast iron, cast or forged steel, or bronze. When made of the two latter materials some peculiar or extraordinary service is required of the gear—with the discussion of which we are not concerned. By far the greatest number of gears are made from cast iron and cast steel. Concerning the relative advantages of these two materials there is much difference of opinion. Of late years users of gears have quite run away with the idea that cast steel gears are best under any and all conditions. Nothing could be more erroneous; nothing more outrageously violates scientific knowledge. Under all ordinary conditions cast steel gears have but a single sharply defined superiority over cast-iron gears, *i. e.*, that of greater strength. Nor has this fact been clearly apprehended by designers, for no appreciable reduction has been made in the size of the hubs, arms or rims of gears out of consideration of the fact that they are made of steel—cast-iron sizes prevailing in all cases.

True economy is here altogether lost sight of; for, obviously, if cast steel is the stronger material, less of it should be used. How much less is the question. Designers may calculate and engineers may judge, but experience alone can demonstrate. The practical determination of this point must necessarily take years to effect, just as it did in the case of the cast-iron gears. Unfortunately the element of time cannot be eliminated. Until this important matter is satisfactorily settled all efforts for economy must be ignored in the matter of cast steel gears; a higher price must be paid per pound and an extravagant amount of material used.

On the other hand, cast iron has a number of distinct advantages over cast steel, both for the designer and the user. Cast iron is a much easier metal to work with than cast steel, having less shrinkage and less warpage than cast steel; nor will it so readily transmit vibration. This latter peculiarity can readily be demonstrated by striking with a hammer on a wheel of cast steel and on one of cast iron. The tone of the resulting noise is much higher in pitch in the case of the cast steel, due to the shorter and more rapid vibrations. The noise from the cast iron is lower in tone and of shorter duration, due to the opposite conditions. Thus cast-iron gears immediately take the preference from the standpoint of closest approach to silence in operation. It may here be said that it is a scientifically proven fact that workmen subjected to loud, raucous noises at their work become dull and sluggish in their mental processes, and their efficiency falls in exact proportion.

Only in exceptional cases is it necessary to use cast steel gears for their superior strength. In the vast majority of cases a good cast-iron gear is amply strong enough for the service required of it. There are three conventional methods of making gears. When the teeth are to be cut the rim of the pattern is made a solid blank. The resulting casting is bored, turned on its periphery and faced on both sides of the rim. The finished blank is then put on the gear-cutting machine and the teeth cut as desired. The two remaining methods relate to gears designed to have cast teeth. In the one case a full pattern is made; that is, all the teeth are cut on the pattern. This is the old fashioned, expensive way which entails a vast deal of labor both in the laying out and the formation of the teeth. Although tooth-forming machines have done much to relieve this situation in the jobbing shops, the spacing of the formed teeth on the periphery of the wheel is extremely difficult to do accurately—simple as it looks to those who have never had it to do. The other method referred to is that of machine-molding the gear. This is by far the best method, being the simplest, most accurate and the cheapest. All that is required in the way of a pattern is a sweep, a part of the hub, an arm, and a tooth block. The latter is fixed on the arm of the machine and two or three teeth, as may be desired, are rammed at a time, the spacing being done with absolute precision by the machine. The chances for inaccuracy are reduced to a minimum; the whole trick is up to the patternmaker and, since his efforts are confined to but two or three teeth on the block, he concentrates his whole ability there, with the result that a perfect gear is produced. The clearances in a well made machine-molded gear may be just as close as in a cut gear of the same pitch. The comparative ease with which machine-molded iron gears can be made makes them by far the most economical to use, and if this fact were better known to engineers and designers of machinery, cast-iron gears produced by this method would invariably be specified.

Everyone familiar with foundry practice knows that the outside skin of a casting is its hardest part. This single peculiarity lends to machine-molded cast-iron gears the soundest argument in their favor. It takes long service to wear through this hard shell on the faces of the teeth, whereas in the case of cut gears, all of this valuable wearing surface is entirely cut away before the wheels go into service. Cast steel gears do not have these advantages. The high temperature at which steel is poured necessitates the use of silica sand in the molds. This has to be rammed so hard that machines cannot conveniently be used, making a full pattern necessary. Moreover, steel castings are hard to make; it takes a "real molder" to make a good one. Since nearly all the labor in the steel foundries is done by unskilled foreigners, who do not appreciate the niceties of gear molding, it is extremely difficult to get a good cast steel gear, accurate to pitch, round, and true to theoretical tooth contour. The silica sand burns to the faces of the teeth, which "scabs" and "pits" them, so that almost invariably every tooth face has to be chipped to secure even an indifferent bearing: hence the noise and clatter that is so noticeable in cast steel gears with cast teeth. If the teeth do not bear across their entire face, the very object that the designer had in mind is altogether lost.

The matter of shrinkage in cast steel is difficult to control, so much so, in fact, that few manufacturers will guarantee large wheels to come near the pattern allowances. No two wheels will shrink just alike, so that the question of whether the wheels will preserve the circularity of the pattern is in grave doubt. Therefore, aside from exceptional cases where great strength is required, designers should be extremely chary of specifying cast steel gears unless the teeth are to be cut. There is but one principal object in cutting the teeth of gear wheels: there are a number of minor reasons. The first is to insure perfect tooth contact; the others are to lessen the noise of operation, to improve the appearance of the wheels, to discover flaws in the material, etc. Since perfect contact can be secured by machine-molding the teeth, why cut them? The expense of cutting is an appreciable consideration. If cast iron will do, why use cast steel? Cast iron is by far the cheapest. The argument is advanced that steel wears longest. The hard skin on the teeth of machine-molded gears of cast iron so lengthens their time of service that even that argument is in grave doubt. We are brought face to face with the fact that, after all, nothing can quite take the place of a well made machine-molded cast-iron gear. The matter of the gears is often the largest item of expense in certain classes of machinery, as in the case of bending and straightening machinery. If the greater part of the cost of the gear patterns can be saved by having them of cast iron and machine molded, why not do it? The specification of the cheapest as well as the best gears for the purpose in mind is the true indication of the designer's ability.

* * *

ATTACHING RUBBER TO METALS

Rubber may be attached to alloys containing one of the antimony group of metals by vulcanizing it while in contact with the alloy, and to other metals, by coating them, for instance, by electroplating, with an alloy containing antimony, and vulcanizing the rubber while in contact with this coating.

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* Address: Oakdale, Pa.

AUTOMATIC TURRET MACHINE FOR MACHINING STEAM RADIATORS

BY CHESTER L. LUCAS*

While the automatic drilling and turning of small castings in a turret lathe is an everyday operation, it is somewhat out of the ordinary for similar automatic operations to be performed on castings weighing from fifty to seventy-five pounds.

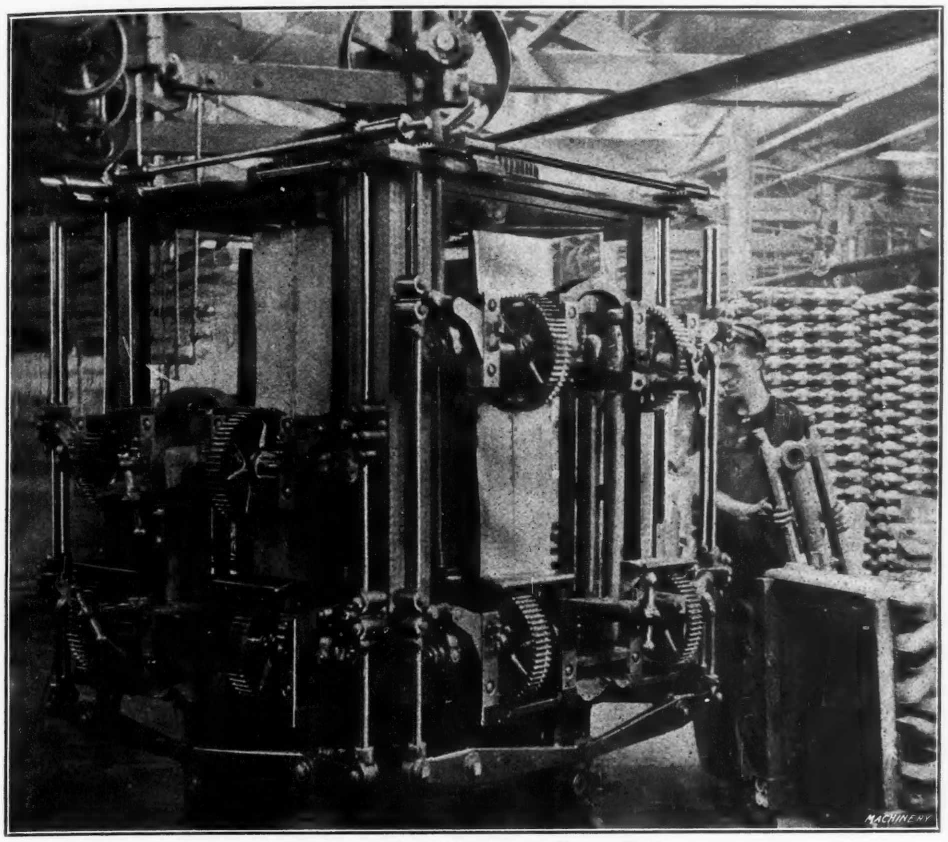


Fig. 1. A Turret Machine for Large Work

This is the class of work, however, that is being done on the automatic drilling and counterboring machine illustrated in Fig. 1. This machine was made by the O. Bryant Machine Co., Buffalo, N. Y., and is in successful operation at the radiator plant of the H. B. Smith Co., Westfield, Mass.

This machine has been nicknamed the "merry-go-round" by the operators, from the fact that the work and tool mechanism revolves continuously about a central supporting post, the entire mechanism of the machine being in the form of a square vertical turret. The turret has four working faces, each of which is provided with a separate set of tools and feeding mechanism, so that each face performs all the work on one casting complete. Referring to Fig. 1, the operator stands at the loading point and clamps a casting in place while the turret is passing. This being done, the feeding mechanism commences to advance the tools, drilling and counterboring at both ends of the casting on its way around the machine, and when the casting comes around again to the operator at the operating point, the work is finished and the casting ready to be taken out and replaced with another piece of work. The machine is continuous in its operation, there being no indexing mechanism of any kind. The main advantage of the turret construction is that the work is automatically returned to the loading point after being finished and the operator can do the removing and loading from one position. At the same time, by having four pieces of work under way at once, there is always one casting ready to be removed.

One of the radiator castings upon which the operations are performed may be seen near the bottom of Fig. 2. On each casting the work consists of drilling out a two-inch cored hole at each end of both sides, making four holes in all. There are four cutting tools working simultaneously on each casting, each of which combines a two-inch drill and a three-inch counterbore. Each of the holes is counterbored to prepare the radiator sections for assembling. These radiator castings come in various styles and lengths so that the machine must be, to a certain extent, adjustable for the various sizes. In order to accommodate the different lengths of castings the upper sets of working tools on each face of the turret may be raised or lowered to suit the particular piece which is being machined.

By referring again to Fig. 1 it will be seen that the cutters on the face of the turret, shown at the right, are working on long castings, while the mechanism on the left-hand face is operating on short castings. This means that the operator must have two piles of castings at the loading point so that when the "short face" comes around he can supply a short length casting, and when the "long face" of the turret appears he can put in a long casting.

A good idea of the feeding mechanism with which each of the turret faces is supplied, may be had by referring to Fig. 2. Here the casting is shown at *A*, being clamped in position by

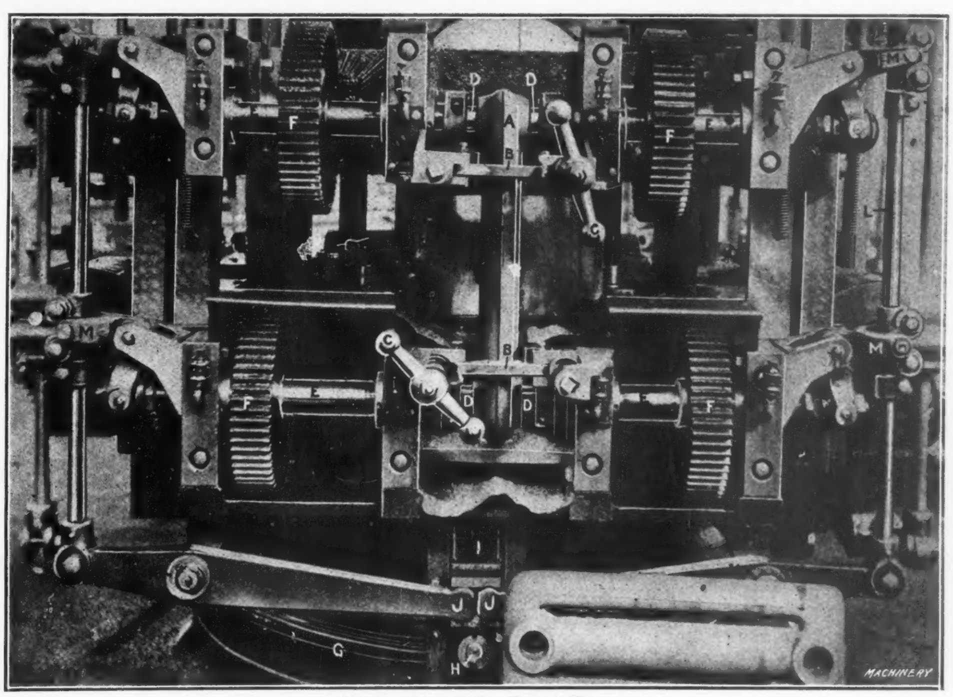


Fig. 2. One of the Turret Faces

straps *B*, which are held in place by means of levers *C*. The cutting tools are shown at both sides of the top and bottom of the casting at *D*. These tools are operated from corresponding shafts *E*, which receive their motion through vertical shafts at the rear of each face, and these are, in turn,

*Associate Editor of MACHINERY.

operated by spur gearing from the central stud. The spur gears are at the top of the machine and may be seen in Fig. 1. Motion from the vertical shafts is transmitted to the tool spindles by means of bevel gearing. The tools on the opposite sides of the work revolve in opposite directions; therefore the cutting tools on one side of the work must be made left-handed. Upon auxiliary shafts, behind each face of the turret, are the broad faced driving gears which mesh with tool spindle gears *F*. These broad faced gears are wide enough so that the gears *F* which are fixed upon the tool spindles may have travel enough to allow for the machining of the work and still be properly in mesh.

The forward feeding of the tool spindles is accomplished in an interesting manner. There is a continuous circular cam track *G* around the base of the machine, and extending from each of the four faces of the turret is a cam roll mounted upon the opposite end of stud *H*, which continuously bears against this track. The cam track is straight at the loading point; that is, there is no rise, but as soon as the loading point is passed, there is a gradual ascent of the cam track, causing the cam roll to rise steadily and forcing slide *I* up with it. Pivoted in this slide are the ends of the two toggles *J*, which are fulcrumed upon studs *K* on the turret face. Therefore, as the inner ends of the toggles are raised, the outer ends are depressed, and carry downward with them vertical shafts *L*. Upon these shafts *L* are mounted bellcranks *M*, which, through connections at their lower ends with tool spindles *E*, tend to force these spindles inward when shafts *L* are lowered. Thus as long as the ascent in the cam track is maintained, the tool spindles feed in, causing the drilling and counterboring tools to act on the work from both sides of the casting. The cam track is made perfectly straight for the last one-eighth revolution, so that the counterboring tools simply revolve against the work and smooth the surfaces. This is just previous to the ejecting and loading point, at which time there is an abrupt drop in the cam track, allowing the spindles to retreat, and permitting the operator to unclamp the work and set in a new piece before the commencement of the cam ascent is reached again by the turret.

* * *

HIGH-SPEED SHAFTING

BY J. E. LINABURY*

One of the most significant steps in the advancement of machine shop economics, since the introduction of high-speed steel, has been the advent of high-speed lineshafting and small high-speed belts, made possible by the use of ball bearing shaft hangers. The increased friction from high rotative speed, and the low melting point of babbitt bearings have, after many years, established an average lineshaft speed of from 150 to 200 R. P. M. Occasionally, by extremely careful attention to lubrication and alignment, 300 R. P. M. has been reached, but rarely any more. This low rotative speed has made comparatively large size shafting necessary, thus adding to the weight and cost. If a motor is used for power, its speed is usually from 900 to 1200 R. P. M. It is generally conceded that a belt will give the most efficient service at a velocity of from 4000 to 4800 feet per minute. To get this the motor pulley should be 15 to 18 inches in diameter. If the main shaft turns at 200 R. P. M., its driving pulley would then be from 5 to 7 feet in diameter, with an alternative of a heavier and more expensive belt with greater tension, or a smaller pulley—usually the latter. This holds true with regard to all the pulleys on the main shaft; either the pulleys are excessively large and heavy, or the belts are not working to their best efficiency. When a 2-inch belt, costing 20 cents per foot, might be used, a 4-inch belt, costing 40 cents per foot, is required.

The ball bearing hanger, however, has changed much of this. Now many progressive engineers, looking everywhere to save installation and manufacturing charges, lay out their main and countershafting to run in ball bearings at 400 to 600 R. P. M., using light narrow pulleys and narrow belts, thus saving materially in total first cost, and from 50 to 75 per cent of the power consumed in the shafting, which in the majority of cases is not less than 40 per cent of the total power used. They also save in maintenance, for where the old type of hanger required lubrication every day, the ball bearings do not require attention oftener than once in four months.

Let us make a cost comparison of two lines of shafting, 100 feet in length, say, transmitting the same horsepower. Let the first be 2 7/16 inches in diameter, and turning on babbitt bearings at 200 R. P. M., with hangers every eight feet. Between hangers consider two 30-inch pulleys, with 4-inch belts, each 25 feet long. Each foot of this shaft weighs 15.87 pounds, or 1587 pounds in all, costing 2¼ cents per pound, or about $35.60. To transmit the same amount of power with ball bearing hangers at 600 R. P. M. will require a shaft only 1 11/16 inch in diameter, weighing 7.6 pounds per foot, or 760 pounds in all, and costing but $17.10. This means a saving of 827 pounds in weight, and $18.50 in cost. Where two 30-inch pulleys with 4-inch face were used in each bay in the first case, with the high-speed shaft, 20-inch pulleys with a 2-inch face will do the work. This saving in pulleys is about 50 per cent in their weight, and $3 a piece in their cost, or $72 in the total pulley cost of 24 pulleys. With the slow shaft, using 25 feet per pulley, 600 feet of 4-inch belt, costing about $240, would be required; while with the high-speed shaft, 2-inch belt, costing $120 would handle the same work. From this it is apparent that by the use of the ball bearing hangers, the saving in the initial cost of shafting, pulleys and belting is $210.50 in one 100 feet. While the ball bearing hangers cost more than the plain ones, the difference will not be as much as their saving in first cost. Add to this the longer life of the hanger, the freedom from dripping grease, the brighter, neater appearance overhead, the low maintenance charge, with a probable saving of 20 to 30 per cent in total power used, and one realizes the reason for ball bearing hangers becoming so generally popular. The use of high-speed shafting has not been confined to manufacturers using specialized machines, but to practically all classes of work. General machine departments, grinders, automatic machines, and the rigid and varied requirements of a toolroom, all find the application most practical, and reap the benefit of a lighter, brighter and quieter overhead construction, coupled with economy in installation, maintenance and power.

* Address: Care of New Departure Mfg. Co., Hartford, Conn.

* * *

WHERE IS THE FALLACY?

The "proof" below indicates that any two unequal numbers may algebraically be shown to be equal.

Let a and b be the two unequal numbers. Let c be their arithmetical mean; that is, $(a + b) \div 2 = c$, or $a + b = 2c$.

Then:

$$(a + b)\,(a - b) = 2c(a - b)$$
$$a^2 - b^2 = 2ac - 2bc$$
$$a^2 - 2ac = b^2 - 2bc$$
$$a^2 - 2ac + c^2 = b^2 - 2bc + c^2$$
$$(a - c)^2 = (b - c)^2$$
$$a - c = b - c$$

Hence $a = b$

But a and b were assumed to be unequal.

* * *

A fleet of large self-propelled barges, fifteen in number, to ply between New Orleans and the coal fields of northern Alabama, is of interest in that they are the first craft of their kind in America to be propelled by producer gas engines. The barges are of steel construction, and are similar in design to those in use on the canals of Holland. Their measurements are as follows: Length, 240 feet; width on deck, 32 feet; width at bottom, 28 feet; depth, sides, 8 feet; depth, center, 8½ feet. Their capacity is 1000 tons, and the draft when fully loaded is 7 feet. They are propelled by twin screws driven by twin engines and have a speed of approximately seven miles an hour when fully loaded. The weight of each barge and equipment is close to 240 tons. The screws are driven at 300 R. P. M. by two 75 H. P. Fairbanks, Morse & Co. vertical producer gas engines. Gas for the engine is furnished by a 150 H. P. producer, made by the same company. The fuel used for the producer is what has heretofore been a waste coke from the ovens of the Birmingham district, and which consequently is secured at a low price.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

CONCERNING AN OFFSET DRILL HEAD

Fig. 1 shows the sub-base of a machine which was to be built in large quantities. Its size and weight made it very desirable to do all of the drilling on a radial drill. The holes *A* were easy enough to drill, but holes *B*, being at right angles with the others and parallel with the drill press platen, gave considerable trouble, and much time was lost by using

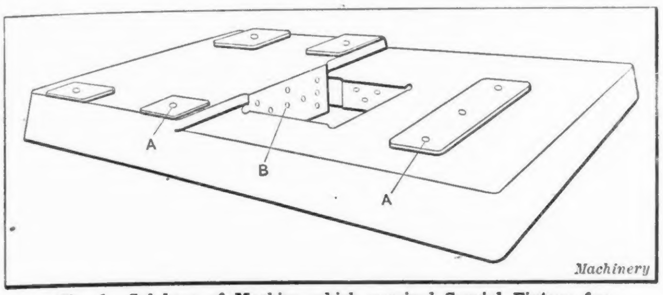


Fig. 1. Sub-base of Machine which required Special Fixture for drilling Holes B

a small ratchet drill. The saving that would be effected by drilling these holes with a power-driven drill head warranted designing and making the special tool shown in Fig. 2, which cost but $26 to make and has proved entirely satisfactory.

The yoke *D* is securely clamped to the radial drill spindle. The yoke extension *E* is hung to the yoke *D*, with a screwed-on plate *F*, so constructed that the yoke extension can be turned to any angle in relation to the radial drill arm and set by means of the lever *G* and its brass plug *H*. At *J* is shown a short drill with a taper shank which enters the collet *K*. This collet *K* is keyed to a miter gear *M*, which, in turn, is driven by gear *O*, the hub of gear *M* being freely mounted in bushing *N*. The gear *O* is fastened to the spindle

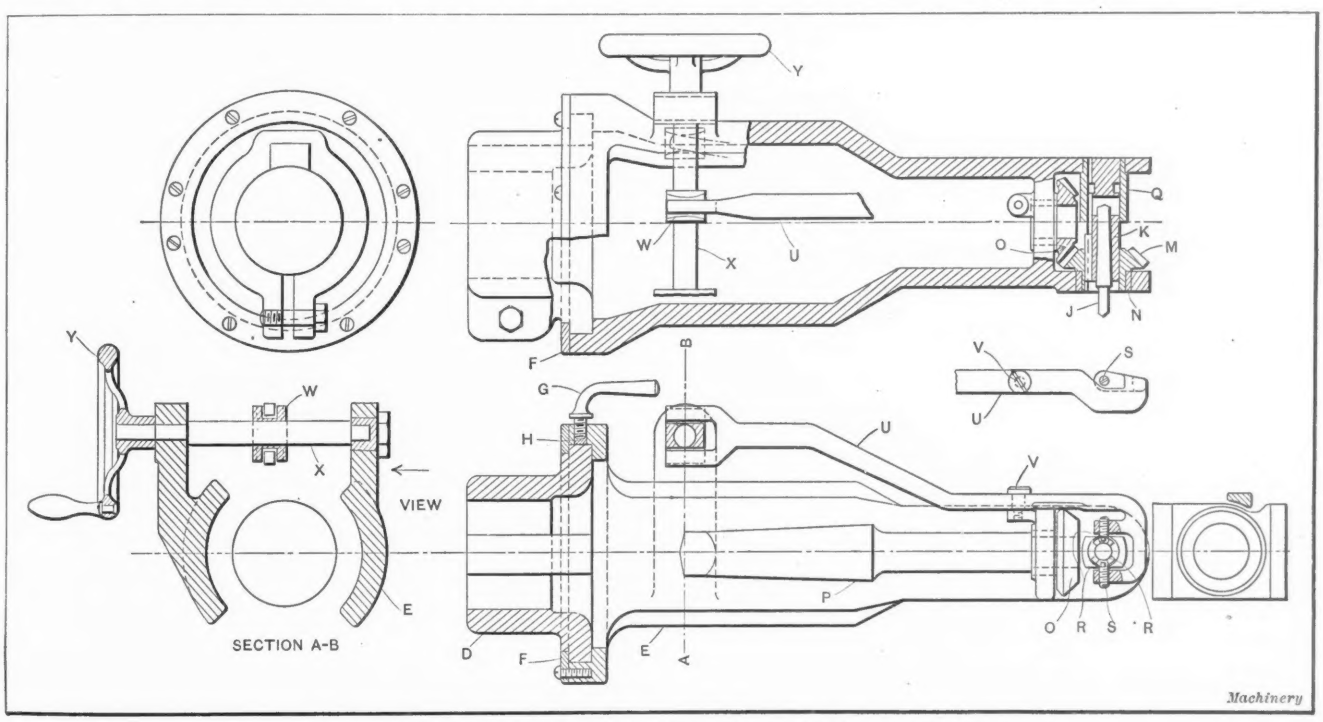


Fig. 2. Offset Drill Head designed for drilling Horizontal Holes on Radial Drill

P, which enters the taper collet in the radial drill spindle. The drill-holding collet *K* is supported by a bushing *Q*, which is slabbed off and slotted as shown in the illustration. Two small crescent-shaped pieces *R* are fitted into collet *K*, and two screw pins *S* inserted through slots in the bushing *Q*. These screws are set in the lever *U*, which is fulcrumed at *V* and propelled as shown by means of the block *W*. The screw *X* and handwheel *Y* allow the operator to feed the drill with ease.

Although at the first glance the construction of the smaller working parts of this drill head may appear frail, it must not be forgotten that it will enter an opening that is but 5 by 3½ inches in size and drill a ½-inch hole 1¼ inch from the side of the opening quite as rapidly as under ordinary conditions. This special head has paid for itself many times in the saving which it has effected in drilling the horizontal holes in the sub-bases. RICHARD RUSSELL

TURRET LATHE SET-UP FOR A SMALL SCREW

"To cut costs, cut the cutting time and cut the time between cuts" is a slogan which has been popularized by the Bullard Machine Tool Co. This advice applies to all classes of machining operations, and scientific management is merely a "classical" title for this simple formula for cutting costs. It will be readily understood that in certain operations it is more important to make a reduction in the cutting time, while in other cases the time between cuts is more easily reduced. Of course, if both the cutting time and the time between cuts can be reduced a still greater saving will be effected.

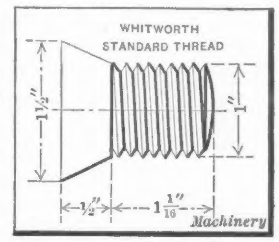
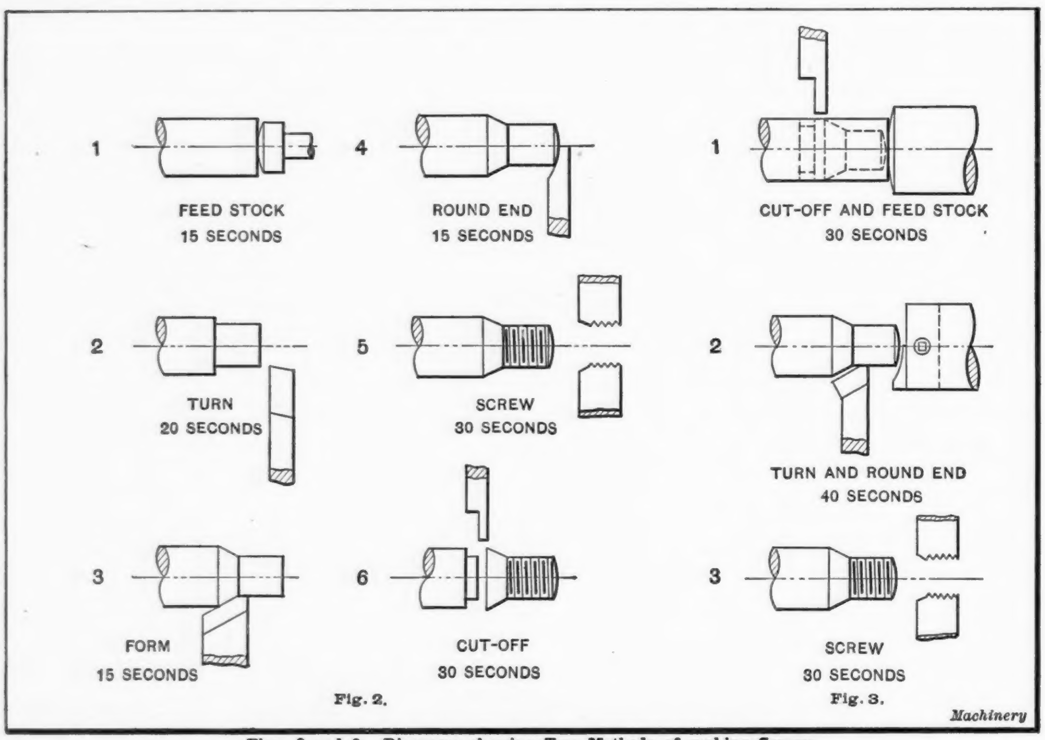


Fig. 1. Screw to be made

It is the purpose of this article to describe the method by which both the cutting time and time between cuts were reduced in making the countersunk head screw shown in Fig. 1. It will be evident that if a sufficient number of these screws had been required it would have been quite a simple job for the "automatic." It happened, however, that the quantity required was not large, and a more serious objection lay in the fact that the equipment of our shop did not include an automatic screw machine. Consequently the only alternative was to do the work on the most suitable hand-operated machine which was a Herbert No. 2 turret lathe, taking bars up to 2¼ inches in diameter. Fig. 2 shows what would ordinarily be the sequence of operations from feeding the stock in the first operation to cutting off the finished screw in the sixth, the time for each being given. It must be understood that each of these operations required a separate face of the turret so that it was necessary to advance and withdraw the turret

six times to complete a single screw. With a heavy turret and carriage, such as the one used on the Herbert No. 2 machine, these hand movements became decidedly monotonous and fatiguing when the machine was being operated on such short cuts.

To reduce the number of idle movements to a minimum, the tool set-up shown in Fig. 3 was adopted. By combining certain cuts this arrangement did away with three operations, so that instead of advancing and withdrawing the turret six times for each complete screw, only three movements of the turret were necessary. The operation of feeding the stock is accomplished without having to move the turret from the cut-off position, a piece of cold-drawn bar being clamped in the turret hole to act as a stop. The second operation of the new system combines the second, third and fourth operations of the original method. Referring to the illustration it will be seen that the turning tool is shaped to form the head of the screw as well as to turn the body, and a second cutter carried by a bar clamped in the turret hole forms the end of the screw. In operating the machine according to the second method the feed is tripped just before the tool which forms the end of the screw starts to cut, so that the actual ending and forming of the head is done by hand. The third operation consists of threading the screw, after which the piece is cut off and the bar fed up to the stop ready for the next sequence of operations.



Figs. 2 and 3. Diagrams showing Two Methods of making Screws

Referring to the notation showing the time of each operation according to the two methods, it will be seen that it required only 100 seconds to complete a screw when the second method of tooling was used, while 125 seconds was required by the original method. This saving may not appear very substantial, but it is certainly worth while, and it is also possible that a much greater saving could be effected on a long run because the operator would not be fatigued so soon. The only outlay involved in changing over to this new method of tooling was for the forming tool used for the second operation; the stop and the ending tool were also of special design, but as they could be used to advantage on many other classes of work they were not charged to this particular job.

ALBION

SOME EVERYDAY SHOP PROBLEMS

As it has come to my notice that some of the common operations performed in machine shops every day present apparently insurmountable difficulties to apprentices and to some so-called "journeymen," I will describe briefly my methods of doing certain work in the hope that they will be of help and benefit to some who have had troubles.

I have particularly noticed the difficulties that some machinists have in squaring up a piece in a shaper vise. I have seen machinists who had the reputation of being a little better than the average, spend a great deal of time and energy taking many cuts over a block jig which had to be planed on all six sides. Work of this kind can be done quickly and accurately if the procedure is right. My method is to plane one side with a roughing tool and then place that side against the back jaw of the vise with a round piece of stock between the opposite side and the vise jaw in order to hold it securely against the back jaw. A rough cut is taken off the side then presented to the tool. In this way, I proceed until the block is planed on four sides. Then the block is tested with a square to find two sides that are square. These are marked with chalk.

A piece of scrap cast iron about the size of the jig is then placed in the vise, pinched with the jaws, and a cut is taken from it. The jig to be finished is then placed on this false bottom using pinch parallels to hold it with the square or chalked side down. A finishing cut is taken over the block, continuing around until finished all over.

I do not pretend to say that this is the best method of doing work of this kind, but I have met success with this method of procedure and having seen so many failures when men have tried to do it other ways, believe that the reader will find my way produces satisfactory work with a minimum of labor and trouble.

Another difficult job for many mechanics is planing a pair of V-blocks so that the vees come exactly central in the blocks. I have seen many mechanics who did not seem to be able to do this simple job without spending a great deal of time at it. The way I plane V-blocks is to rough out the vees first and then finish them, placing one at a time on the false bottom of the vise. The planer head is set at an angle of 45 degrees and a cut taken down the side of the vee, being sure that the block is held down firmly on the bottom and against the back jaw of the vise. Now without moving the table run the head up for another cut and reverse the block. Take the finishing cut down the other side of the vee and finish the other block in the same way. This procedure will produce the V-blocks with the vees as nearly central as it is possible to get them.

Another kink that is sometimes found useful in turning quick tapers on a lathe is using the taper attachment in combination with the tailstock set-over. When the required taper is greater than can be obtained with the taper attachment, swing the attachment as far as it will go and then set the tailstock over sufficiently to make up the required taper.

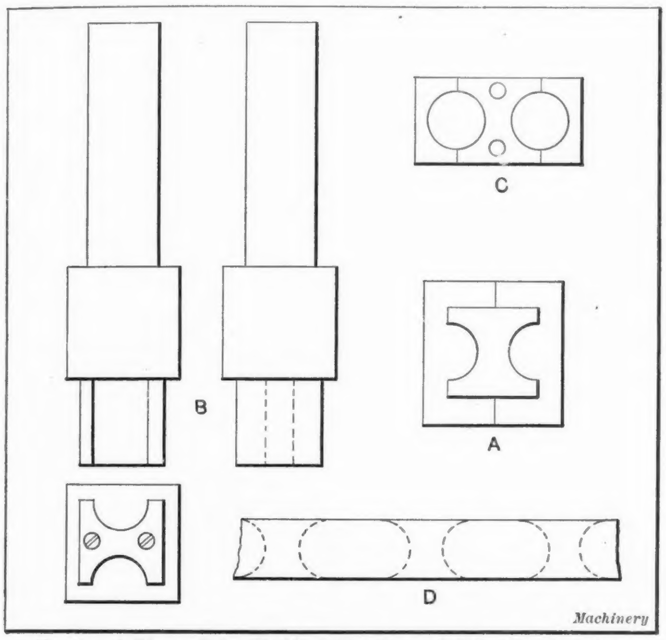
Some men seem to think that figures were invented for office use only. If they see a machinist working with a pencil and note book, they are likely to turn up their noses and say, "We don't take any stock in book learning. Experience is the best thing." Did you ever notice that "what such men lack in the head, they usually make up in the heel"? In other words, they have to do a great deal of walking and trying and cutting and fitting to accomplish what a short calculation will often do. For example, we had some square pieces that were required to be screwed in place and to stand at a certain angle when screwed in tight. The pieces were threaded eight threads per inch. Hence one complete turn would advance the piece 0.125 inch; that is, 360 degrees angular movement

would advance the piece 0.125 inch. Now, dividing 0.125 by 360 gives 0.000347 or 0.00035 inch, which is close enough for any common practice, as the advance for 1 degree. Now for the application of the figures: First, try the piece in the hole and set the bevel protractor on it, and ascertain the number of degrees it has to travel to stand at the required angle. Say, for example, it has to be turned 15 degrees. Now multiplying 0.00035 by 15 gives 0.00525 or practically 0.005 inch as the amount to be faced off in order to have the parts stand at the required angle.

Sharon, Pa. ROY B. PLATT

A LABOR-SAVING SHEAR

In an establishment where the writer was recently employed, long strips of iron, both flat and bevel-edged, were cut into shorter lengths for use on various "ironing" operations on vehicles. In order to give the ends of the pieces a more finished appearance, they were (after being cut off on an ordinary shear) rounded with a suitable die. This, of course, necessitated a second handling. Later, both the cutting and rounding were completed at one operation by the use of the special shear (or, properly speaking, punch and die) illustrated herewith. This device is adapted to cutting off a variety of widths and thicknesses, and has the additional advantage of being made entirely on a lathe and shaper, which will recommend it to many shops where the tool equipment is limited.



Punch and Die used for Combined Shearing and Trimming Operation

The die block *A* is made in two parts, doweled together. This enables the die to be cut out in the shaper, one-half at a time, and also makes it possible to readily vary the clearance between the punch and die. It can be made of almost any desired size, to suit the stock used. The one mentioned cuts the ends of the pieces with a radius of 5/8 inch, while the stock used varies in width from 3/4 inch to 1 1/4 inch, and in thickness from 3/16 to 3/8 inch.

The punch *B*, which at first glance looks like a difficult shape to produce, is easily completed by using a piece of steel considerably longer than the finished punch, and boring two holes of equal size clear through the block. Afterward, the two ends of the piece are cut off, as shown at *C*. The waste of steel made necessary by this method is more than made up by the saving in time that is effected. The punch is afterward fitted to a holder suitable for the press used.

The strips of iron are fed against stops set for the length required, and the portions of the strips *D* between the dotted semicircles are completely punched out of the strip, thus both cutting off and rounding the ends of the pieces at one handling.

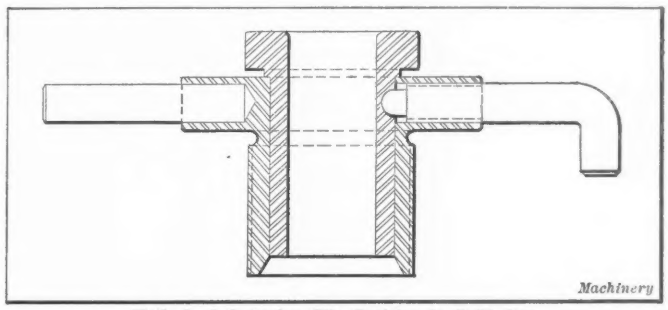
The punch may be made quite narrow in the middle and thus the amount of stock lost in cutting will be very small. Many small pieces used in "ironing" wagons, auto bodies, and on many other manufactured articles can be greatly improved in appearance by cutting off the stock in this manner, and the cost of so doing is no greater than the usual method of employing a common shear for this purpose.

Troy, Ohio. HENRY J. BECK

METHOD OF FASTENING SLIP BUSHINGS

The April and June numbers of MACHINERY contained articles and drawings of different methods of fastening slip bushings in drill jigs to prevent them from crawling up on the drills. I would like to add the accompanying example and explanation to those already given.

As slip bushings are used to a greater extent in screw bell bushings than in other styles, and as it is always necessary to provide some means for screwing down the bell bushings, four pieces of drill rod inserted in the bell bushing as shown, and at right angles to each other, seem to constitute the most satisfactory way of doing this. As shown in the illustration, in place of one of the pieces of drill rod, a hole is tapped out and a form of set-screw is used with the end turned to some convenient radius, as 1/8 inch. Then the slip bushing is drilled at one point so that as the screw is turned in, it engages in the hole provided in the bushing and locks it firmly in place, thus answering the double purpose of a lock for the bushing and a prong to simplify the screwing in and out of the bell bushing.



Method of fastening Slip Bushing in Drill Jigs

Lima, Ohio. R. E. DODGE

THREAD CUTTING TOOLS

The process of thread cutting has been widely discussed from both practical and theoretical standpoints. The various thread forms have been described and established, but very little definite information on cutting threads has been made public, and accurate thread cutting still remains a problem for the individual to solve.

A number of threading tools are on the market which answer the purpose of screw cutting fairly well, but screw cutting should be clearly distinguished from thread cutting in the reader's mind. Screw cutting may be considered as a commercial operation on bolts, screws, studs, etc., whereas I consider thread cutting to be an accurate operation in which the form of thread, the lead and the angle diameter have to be rigidly adhered to. In the last few years the writer has been employed on accurate thread cutting and in the follow-

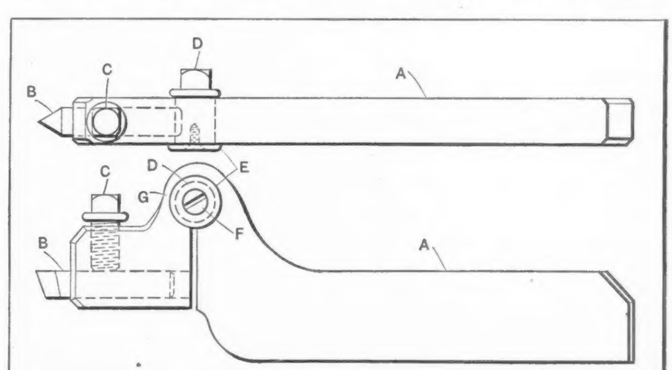


Fig. 1. Gooseneck Threading Tool

ing he will endeavor to describe some of the tools that have been successfully used and which may be useful to others:

Fig. 1 shows an outside threading tool of the gooseneck form. The holder *A* is forged from 1/2 by 1 inch tool steel stock. *B* is an inserted tool made from round stock, preferably turned down from a larger size, high quality steel rod to about 5/16-inch diameter. It is held in position by the set-screw *C*. As the tool body is round, it can be set for any lead to cut the required angle. This is one of the principal requirements of an accurate thread cutting tool. *D* is a plug by which the desired amount of spring in the gooseneck is regulated. The hole in which the plug is fitted is drilled to the desired size, 1/2 inch being the diameter of the hole in the tool shown, and the bottom part is filed slightly, so as to produce an elongated or oval hole. The plug *D* is also made slightly oval and is fitted loosely in the hole, being held in place by a flat-head screw and washer, *F* and *E*. The hole in the stock may be countersunk, if preferred, and the wedge bolt *D* riveted over to hold it in place.

In laying out the holder, care should be taken that the hole is so placed that the weakest part of the gooseneck is at a point *G*, about midway between the horizontal and vertical, next to the tool. The thickness should gradually increase toward the back of the stock. This shape of holder causes the tool to spring away from the cut when the pressure becomes heavy and does away with all tendency to dig in. In roughing, the wedge bolt *D* is twisted, preferably so as to bring the high point to the front beneath *G*. This makes the tool quite rigid but still leaves a slight amount of spring available. When the finishing cut is taken, the wedge bolt is loosened so that the full spring of the gooseneck is available.

An objection may be offered to the design of the tool because it is not offset as ordinary gooseneck tools often are, and for that reason threading cannot be done close to a shoulder. The objection to offsetting is that it causes a sideways deflection of the tool, often resulting in roughing or tearing the thread. These tendencies are much reduced when the tool is set at right angles to the work where it gets the stiffest possible support. As to the objection that a shoulder cannot be worked to closely, the class of work on which accurate threading is required, in most cases, has either a shank or an arbor extending beyond the thread, thus giving ample space for the toolpost and tool when set in the right-angle position. Examples are taps, gages, various forms of hobs, etc.

Fig. 2 shows an inserted-cutter inside threading tool and holder. The tool-holder *A* is made of a 1/2-inch piece of drill rod with a 3/32-inch hole drilled through the end at an angle of 30 degrees. The hole is drilled and tapped at right angles for a 3/8-inch hollow set-screw and acts as a clamp-screw. The set-

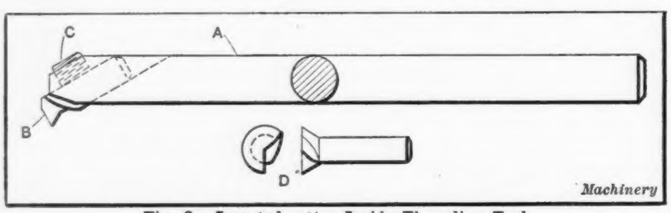


Fig. 2. Inserted-cutter Inside Threading Tool

screw must be short if limited in height to the over-all dimension of the holder, but the writer has proved out this type of holder under hard test and has found the short screw amply strong to hold the tool firmly in position. He has used a 3/8-inch standard hollow set-screw of only three or four threads length, but if desired, users can make special set-screws with finer and more threads.

The tool *B* is a round piece of tool steel ground to the shape shown in the illustration. This tool also possesses the important feature of lead angle adjustment as mentioned in connection with the description of the gooseneck holder, Fig. 1. It has another equally important feature, which is that it extends beyond the holder so as to make it convenient to reach to the bottom of a hole or to a shoulder, as is often necessary in inside threading work. *D* shows another form of cutter adapted to this holder which possesses the feature of lead angle adjustment and in addition, being circular in form, may be ground many times, the form remaining unchanged. It is at a disadvantage, however, in small openings or when working close to the bottom of a hole or shoulder, because the opposite part of the cutter projects beyond the cutting edge and thus prevents the cutting edge working as close to a shoulder as the form shown in Fig. 2.

Fig. 3 shows a center gage which the writer has found to be superior to the ordinary flat type. Its design resulted from necessity, illustrating again the fact that necessity is the mother of invention. The writer had to cut a hob having a 90-degree thread and knew of no reliable way of setting the tool correctly, until the idea of this tool was conceived. The scrap box furnished the stock which was accurately centered. The 90-degree angle groove was cut by using a compound rest. This gage is placed between the lathe centers and the tool set in the groove. The 90-degree angle groove was found to work so satisfactorily that a 60-degree angle groove, a 55-degree angle groove and a square groove were also cut. Both ends were

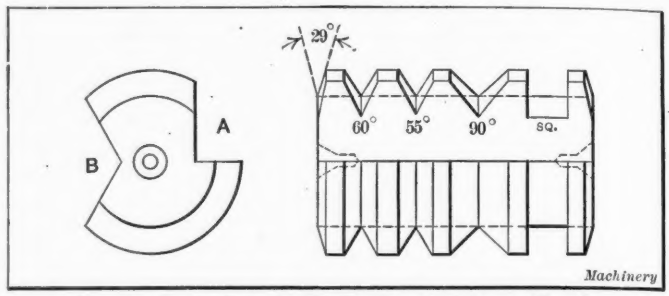


Fig. 3. Center Gage for 29, 55, 60 and 90-degree Threads and Square Threads

faced to an angle of 14 1/2 degrees from the vertical, thus making it available for setting 29-degree angle "Acme" thread tools. The right-angle groove *A* permits the tool to be set flush with the gage and thus favors very accurate adjustment. The tool as first designed did not have the groove *B*, but the need for it was felt when a heavy piece of work between the centers would have required removal had not the gage been adapted to use *against* the work by cutting the groove *B*. The groove *B* permits the gage to be laid against a cylindrical piece of work held between the centers, and used in the same manner as when held between the centers. To set an inside threading tool, the gage is placed with one end against any surface at right angles to the line of center, such as the faceplate, chuck jaws, etc., and with groove *A* facing the threading tool.

After making the gage, the writer found a similar tool in MACHINERY's Reference Book No. 31, but inasmuch as this was original with him and has a strikingly different feature, it probably will be of interest and novelty to many readers.

Waterbury, Conn. JOSEPH WALDMAN

SETTING DIAMONDS

Referring to the article on setting diamonds in the July number, I wish to state that the diamond setting proposition was a troublesome one where I was formerly employed as foreman. The diamonds were held in the holder by a cap screwed onto a piece of 3/8-inch soft steel rod. We were always in trouble with this arrangement because of the cap loosening and the diamonds getting lost. We finally abandoned the use of the screwed cap holders and resorted to solid settings.

The method employed was to drill a hole in the end of a 3/8-inch soft steel rod just large enough to admit the diamond. The diamond was placed in the hole with the largest end at the bottom of the hole, and the end of the rod was peened around the diamond sufficiently to prevent it from falling out. The holder with the diamond in place was then given to the blacksmith who heated it to a white welding heat and with light blows, using a small hand hammer, closed the metal in over the diamond. The holder was then taken to the emery wheel and ground on the end until the diamond touched the wheel.

We found this was a very good method and used it afterwards with satisfaction. The welding heat did not appear to affect the diamond and the light blows having closed the metal around the diamond it was held very tightly when cold. With this setting, emery wheels could be trued many times before having to reset the diamond.

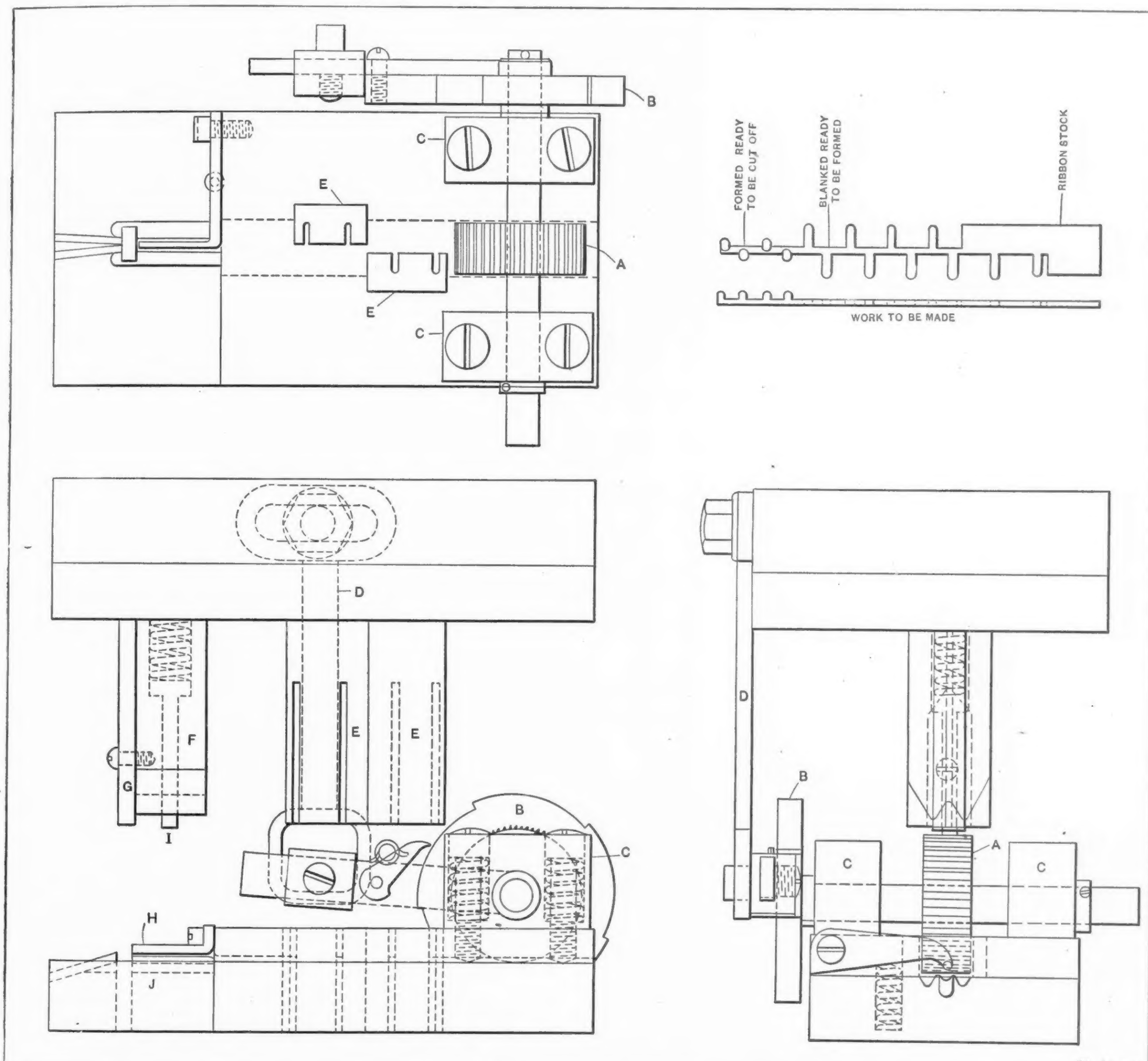
Montreal, Quebec, Canada. MICHAEL MCGIVERN

BLANKING, FORMING AND CUTTING DIE

The punch and die shown was designed for producing the piece illustrated in the detail view. This piece is produced from ribbon brass 0.012 inch in thickness, and at each stroke of the press one piece is blanked, another formed and a third cut off, from which it will be evident that one piece is completed for each stroke of the press. In an average working day this punch and die has a capacity for 60,000 pieces.

Referring to the illustration, the operation of the punch and die may be outlined as follows: The ribbon stock is fed into the die by means of the corrugated roll *A* which is given the required pressure by means of springs under the bolt heads in the pillow blocks *C*. The five-tooth ratchet wheel *B* is mounted on the end of the shaft which carries the feed-roll *A*; this ratchet wheel is operated by the arm *D* which is connected with the punch-holder. At each stroke of the press, the ratchet wheel *B* is rotated one tooth space, and this rotation is transmitted to the feed-roll *A*, thus advancing the stock through a distance of 5/8 inch.

The work is blanked by the punches *E*, formed by the parts *F*, *H*, *I* and *J* which constitute the forming punch and die, and cut off by the blade *G*. The blanking punches are quite simple and any mechanic will understand their operation from the illustration. The forming punch and die is interesting. Referring to the illustration, *H* is a pin about which the prongs which were produced in the blanking operation are curled. As the punch-holder descends, the punch *I* bends the ends of the prongs down around the forming pin *H*. After performing this function the punch *I* rises into the holder against the tension of a spring, and allows the forming punch *F* to come into action. This punch forces the pin *H* down into the forming die *J* and finishes curling the prongs on the work around the forming pin. When the punch-holder rises, the pin *H* is returned to its normal position by the action of a spring. During the upward stroke, the ratchet wheel *B* feeds the stock into position for the next operation, and by so doing the work is pushed off the forming pin. The shear blade *G* then comes into action and cuts off the finished piece against the edge of the forming die *J*.



Blanking, Forming and Cutting Die and Work produced in it

Ambridge, Pa. AUGUST J. LEJEUNE

DETERMINING CHORDAL THICKNESS OF SPIRAL GEAR TEETH

The method of finding the dimensions of spiral gear teeth described by Arthur C. Maxfield seems needlessly complex. A simpler method is submitted in the following:

First find the normal diametral pitch. In the majority of cases this is known, inasmuch as the angles and diameters have been fixed to correspond with regular diametral pitch cutters. Then find by the usual formula, the same as that used for finding the cutter number, the number of teeth in the equivalent spur gear. Take the value given in a table of chordal thicknesses for the new number of teeth and divide by the normal diametral pitch found. The formula for determining the cutter number is:

$$\text{Cutter number} = \frac{\text{number of teeth}}{\cos^3 \text{(spiral angle)}}$$

In the case selected by Mr. Maxfield, *viz.*, 8 teeth, spiral angle 48 degrees, the number of teeth in the equivalent spur gear is found by dividing 8 by $\cos^3$ 48 degrees, which gives us 27.

Manchester, England. FRANCIS W. SHAW

ANALYZING STRENGTH OF CYLINDER HEAD BOLTS

In the July issue of MACHINERY appeared an article entitled "Analyzing Strength of Cylinder Head Bolts." With all due respect to the author, I would like to submit my view of this problem. Mr. Farnsworth, like many others, contends that the internal steam pressure must exceed the total pressure holding the cylinder head on, before any extra tension is exerted upon the cylinder-head bolts. This may be true, but at present I am not convinced.

Fig. 1 shows a sketch similar to that shown in the July number. With a tension of 10 pounds registered on each of the side scales, it is obvious that there must be a compression in the piece *EF* equal to 20 pounds. Now it may appear that the spring-balance at *G* must register 20 pounds before any perceptible difference is noticed on the side scales, but what has become of the compression on the piece *EF*? With no tension on the scale at *G* it would be difficult to remove the piece *EF*, but with the scale at *G* showing a tension of 20 pounds, the piece could be removed without altering the reading on any of the three scales.

Fig. 2 is similar to Fig. 1, with the exception that weights are used instead of the spring-balance. To illustrate more clearly, in Fig. 3 a rubber gasket *I* (exaggerated to illustrate more clearly) is placed between the cover and the cylinder flange. Assuming the cover to have no weight, and the gasket, in a free state, to be 3/8 inch thick, then weights *W* suspended from each of the six bolts, exert a pressure of 60 pounds on the gasket *I* and compress it to a thickness of 1/4 inch. There is a tension of 10 pounds in each of the six bolts, due to the weight on them. Now, if a spring-balance is placed at *G*

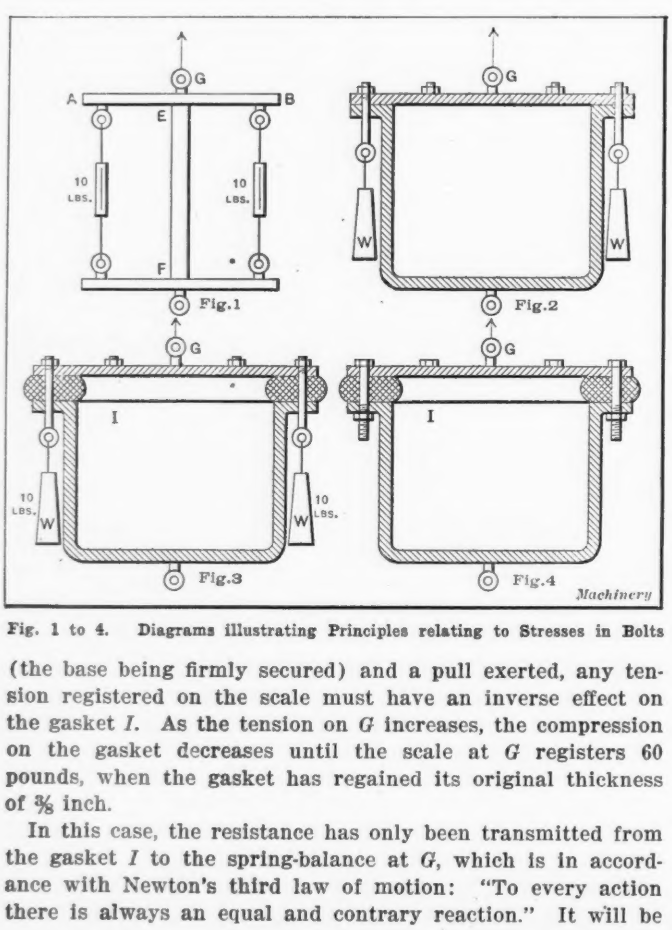
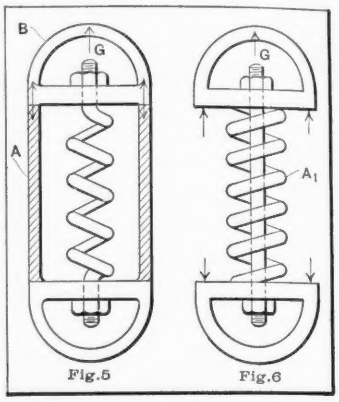


Fig. 1 to 4. Diagrams illustrating Principles relating to Stresses in Bolts

(the base being firmly secured) and a pull exerted, any tension registered on the scale must have an inverse effect on the gasket *I*. As the tension on *G* increases, the compression on the gasket decreases until the scale at *G* registers 60 pounds, when the gasket has regained its original thickness of 3/8 inch.

In this case, the resistance has only been transmitted from the gasket *I* to the spring-balance at *G*, which is in accordance with Newton's third law of motion: "To every action there is always an equal and contrary reaction." It will be clearly seen that there still remains a tension of 10 pounds in each stud, due to the weight *W*, but the cover has risen 1/8 inch due to the pull at *G*. Now in place of a weight being used to give a tension of 10 pounds in each stud, suppose bolts and nuts are used to compress the same gasket from 3/8 inch to 1/4 inch (as shown in Fig. 4.) Then the vital question is: If a pull is exerted at *G*, or an internal pressure of steam or air, or a force of any kind, acts to remove the cover, what is the result? It seems quite evident that a pull of 60 pounds at *G* must double the tension in the bolts, as the gasket (which is compressed to 1/4 inch) is already exerting a force of 60 pounds.

To acquire a certain tension in a stud or bolt, a similar resistance is absolutely necessary, and, if in the case in hand, the resistance of the initial tension of the bolts is taken by the flanges and gaskets, what resists any added pressure? As the compression of the flanges and gaskets is already exerting a force tending to separate the cover from the cylinder, any additional force, be it ever so small, must be added to it.



As the foregoing is only the version of a young mechanic (and perhaps a mistaken one), any light on this apparently debatable subject would be highly appreciated by mechanics in general.

Hamilton, Ont., Canada. JAMES H. RODGERS

[Whether the initial tension on a tightened bolt holding a part subjected to pressure is increased by that pressure before the initial tension is exceeded, depends upon the following conditions: When a bolt is more elastic than the material compressed, the stress in it equals either the initial stress (due to tightening the nut) or the force applied, depending upon which is greater. If the material compressed is more elastic than the bolt, the stress in the bolt equals the initial stress plus the force applied. The principles involved are illustrated by the diagrams, Figs. 5 and 6. The bolt in Fig 5 is in the form of a spring and part *A* is under compression. Now, while an upward pull at *G* would reduce the pressure between parts *A* and *B*, the tension on the bolt would remain constant until pull *G* exceeded the initial tension. In Fig. 6, the bolt is straight and spring A_1 is under compression. In this case, the tension on the bolt equals pull *G* plus the upward thrust of the compressed spring. When flanges are held together in direct contact, they are much more unyielding than bolts, and the condition illustrated by Fig. 5 exists. If they were separated by a gasket more flexible than the bolts, the total stress (as in Fig. 6) would equal the sum of the initial tension and the force applied.

Referring to Fig. 1, obviously the compression on *EF* will diminish as the upward pull *G* is increased, as our correspondent states, but the tension on the side scales (representing the bolts) remains constant until pull *G*, in this case, exceeds 20 pounds. The load is gradually transferred from *EF* to *G*, but without affecting the tension of the side scales, until the pressure on *EF* is reduced to 0; then, any additional upward pull will increase the tension on the side scales. The principle is also illustrated in Fig. 2. If the weights *W* weigh 10 pounds each, it is apparent that the tension of 10 pounds on each bolt will not be increased by an upward pull at *G*. If this same tension had been obtained by tightening the bolts with nuts, it would also remain constant until pull *G* exceeded the total initial tension, unless a flexible gasket were used in the joint. Any upward pull at *G*, however, would reduce the pressure between the flanges. If a thick flexible gasket were used, as shown in Fig. 4, the total stress would equal that due to compressing the gasket plus the pull *G*, because, in this case, the material compressed is more elastic than the bolts. A more complete explanation of the principles involved will be found in MACHINERY's Reference Book No. 22, "Calculation of Elements of Machine Design."—EDITOR.]

EPICYCLIC TRAINS

An epicyclic train is one in which all or some of the gears or wheels have a motion consisting of a revolution about an axis and a revolution or movement of the axis itself.

In Fig. 1, A is called the link or arm of the train. Rotation when right-handed will be considered as positive (+) and when left-handed as negative (—). Gear B has 60 teeth; C, 20 teeth, and D, 30 teeth. Gear B will not rotate. The problem is to find the number of revolutions made by gear D if the arm A makes + 5 turns.

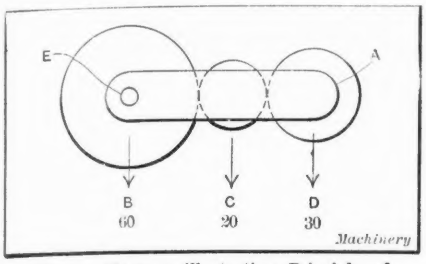


Fig. 1. Diagram illustrating Principle of Epicyclic Trains

There are several methods that can be used in solving, but I believe the following to be the most comprehensive:

	B	D	A
1. Train locked	$+5$	$+5$	$+5$
2. Train unlocked (arm fixed)	-5	$-5 \times \frac{60}{30}$	0
3. Resulting motions (algebraic sum)	0	-5	$+5$

First consider the train locked and turn the arm + 5 times about point E as an axis. This results in the gears and arm being turned + 5 times, as shown in line 1 above. The train is then unlocked and the arm assumed to be fixed. It will be necessary to turn gear B — 5 times in order to make its resultant movement zero, which the problem states is true. The wheel D would then turn $-5 \times \frac{60}{30}$ times, $\frac{60}{30}$ being the ratio of the gears. The resulting motion of each gear and the arm is shown above and is the algebraic sum.

An excellent use to which this principle may be put is shown in the example of the boring bar when used on a lathe or other machine, as illustrated in Fig. 2. Suppose the right-hand screw A has eight threads per inch. It is desired to find the distance the cutter bar B will travel for one positive (+) turn of C, which is the bar placed between centers. We will call the motion of C positive (+) when rotating in the direction of the arrow.

	H	E	C
1. Train locked	$+1$	$+1$	$+1$
2. Train unlocked (arm fixed)	-1	$-\frac{3}{13}$	0
3. Resulting motion	0	$+\frac{10}{13}$	$+1$

With the train locked we assume C (arm) to be turned + 1 revolution, with the result that all the gears would be turned + 1 revolution. With the train unlocked and C stationary, we find it necessary to turn gear H minus one turn in order to have its resultant movement zero, which would be true, as gear H is fixed to the lathe tailstock and cannot rotate. We find that gear E has turned — 3/13 revolution. Adding, we find the resultant motion of E to be + 10/13 revolution. But this is relative to gear H, which is stationary and cannot move. It is necessary to find the turns of gear E relative to C, which is not stationary, but turning about the same axis as E, or $+ 10/13 - 1 = - 3/13$. If the lead-screw A has eight threads per inch (right-handed) the cutter bar B will move $3/13 \times 1/8 = 0.028$ inch to the right for one turn of C.

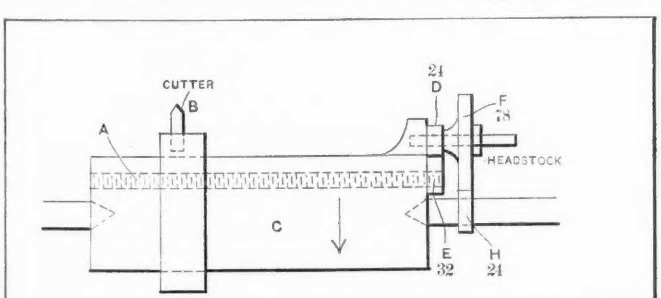


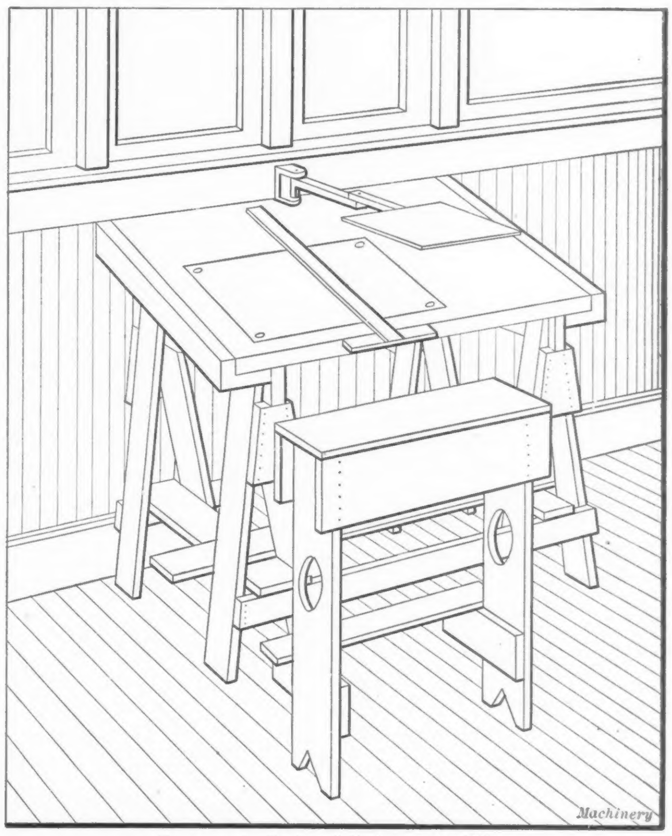
Fig. 2. An Application of the Epicyclic Gear Train

Cliftondale, Mass. I. E. MILLER

DRAFTSMAN'S SEAT AND INSTRUMENT HOLDER

The illustration represents my idea of a well arranged drawing board, seat and instrument holder. I have been using this arrangement for several years and find it satisfactory. A bench seat which will accommodate two persons is convenient when the superintendent or head draftsman wishes to sit down on the seat with the draftsman for a while to inspect a drawing or to talk over matters of detail. The bench is useful also when making large drawings as one can slide along so as to keep his work in front of him. With the draftsman's stool commonly used, it is necessary to stand in order to do very large drawings, as one cannot sit on a stool and reach far.

The seat I use is 11 by 36 inches on top and 25½ inches high. The foot-rest is 8 inches from the floor. The height of the bench is right for that of the drawing board, which is arranged for use either as a stand-up board or when sitting on the seat. The height of the front edge of the drawing board is 33 inches from the floor and this is very nearly right for the average man whose height is about five feet ten inches. The height is right for doing work where the draftsman has to lean over and against the board; it puts the pressure against his body where it will do him the least harm. This is an important consideration when making many large drawings.



Draftsman's Seat and Instrument Holder

The homemade instrument holder over the board is useful for keeping the instruments, scales, squares, etc., out of the way of the T-square, especially when it is necessary to use the T-square to draw in vertical lines. The folding arm of the instrument holder is an old square folding gas fixture. The tray is made of galvanized iron, the edges being folded over so that no square edges are exposed.

Chattanooga, Tenn. R. W. J. STEWART

* * *

A small business of some importance in New York City is the collection of steel filings from machine shops for use in fireworks. The price paid for clean filings in New York City is about twelve cents a pound.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

LANDIS ROLL GRINDING MACHINE

The Landis Tool Co., Waynesboro, Pa., has recently added to its line the roll grinding machine illustrated in Figs. 1 to 4. This machine includes a number of important features in its design and embodies the method of traversing the grinding wheel carriage, which is a distinctive feature of Landis grinders. Uniform and positive lubrication of the ways is provided and a rigid foundation for the work, no matter what its length or weight may be. There is no overhang of the work-table, as it is supported for its entire length by the column of the machine to which it is firmly clamped, thus avoiding vibration; this is a feature which is essential to rapid and accurate grinding. This machine is built in seven sizes. The smallest size is a 16 by 72 inch machine weighing 15,000 pounds, while the largest swings 52 inches, takes 20 feet between centers, and weighs 90,000 pounds.

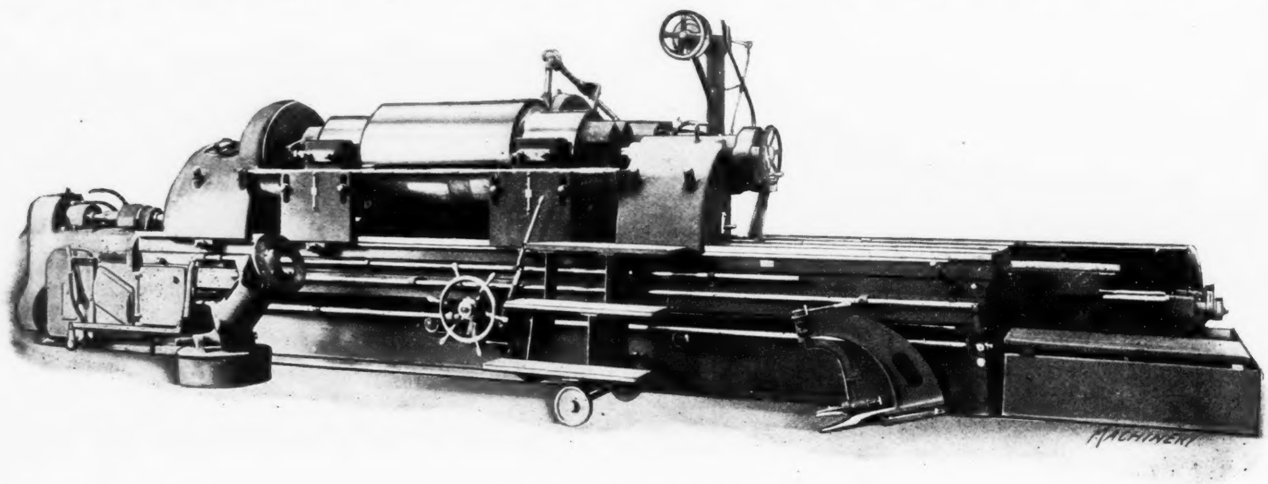


Fig. 1. Front View of Landis Roll Grinding Machine

The machine has been designed for manufacturing purposes and while it is primarily intended for grinding hardened steel and chilled rolls, it is also well suited for finishing a variety of cylindrical work such as large shafts, pistons, Corliss valves, torpedo tubes and similar pieces. The design has been worked out to make the machine entirely self-contained and no overhead works are required except when it is desired to drive the grinder from a lineshaft; in such a case an auxiliary shaft with tight and loose pulleys and a cone pulley over which the belt runs to the machine is required. Owing to the fact that the machine can be operated without any overhead works, it is convenient to place the grinder under a crane for lifting the work into place and removing it.

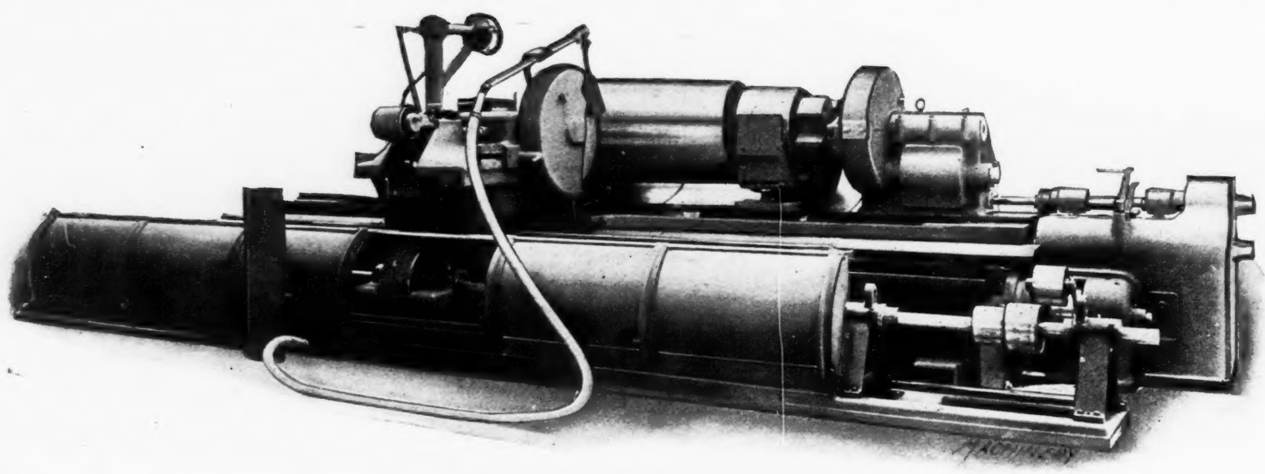


Fig. 2. Rear View of Roll Grinding Machine

Where electric motor drive is employed, the motor is mounted on an extension of the base and can either be connected directly to the driving shaft or power can be transmitted by a belt, as desired. The machine can also be driven by a motor placed on the ceiling or wall, in which case the extension on the base of the machine is not required. The main drive is located at the rear of the machine and consists of a shaft extending the full length of the bed. The different mechanisms are driven from this shaft independently by means of belts. The driving shaft is thoroughly protected for its entire length by means of a sheet metal guard.

The grinding wheel driving pulley traverses with the wheel carriage and is trunnioned in an independent carriage which travels on a track provided for the purpose. The pulley is driven by rolls in its hub engaging with step grooves in the main driving shaft. In traveling, this arrangement makes a practically frictionless driving connection. The grinding wheel belt passes over idler pulleys which are so arranged that its length does not change as the wheel head is moved on the cross-slide. One of the idler pulleys automatically adjusts itself for any change in the length of the belt due to stretching and at the same time keeps it under a uniform tension. The work and traverse speeds are varied independently of each other. This is an important factor in commercial grinding, as it affords the necessary traverse feed for any work speed. For grinding tapers, the table swivels and is provided with two scales which are graduated in degrees and inches per foot, respectively.

The headstock is of heavy construction and powerful gearing is provided for driving the work. The speed changes are made

by an arrangement of levers at the front of the machine. The footstock is operated by a handwheel which is geared to the screw so that the center can easily be run into the heaviest piece of work that the machine will carry. The grinding wheel head is mounted on a vee and flat guide of ample proportions to provide a smooth and positive action when feeding for the lightest cut on the work. The spindle is made of steel and runs in phosphor-bronze bearings which are made with tapers to provide for taking up wear. The bearings have a ball and

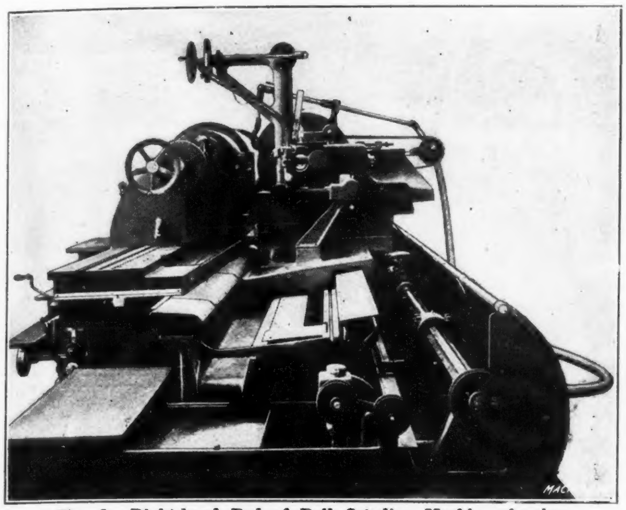


Fig. 3. Right-hand End of Roll Grinding Machine showing Driving Shaft

socket connection with the base, which makes them easy to keep in alignment with the spindle. The grinding wheel is fed to the work either automatically or by hand, and there is also a rapid power feed for moving the wheel back out of the way when changing the work and also for bringing it forward to the grinding position when the machine is ready to be placed in operation. This is an important feature as it saves a considerable amount of time as well as making the operation of the grinding machine simple and convenient. The rapid power feed is independent of the hand and automatic feed, being operated by a lever and simple arrangement of clutches. The automatic cross feed for the grinding wheel operates at each reversal of the wheel carriage and can be set to reduce the work diameter from 0.00025 to 0.012 inch at each traverse.

The grinding wheel is provided with three truing fixtures.

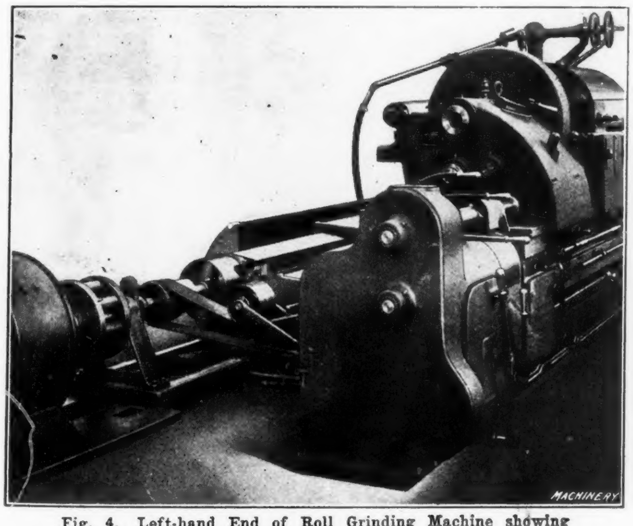


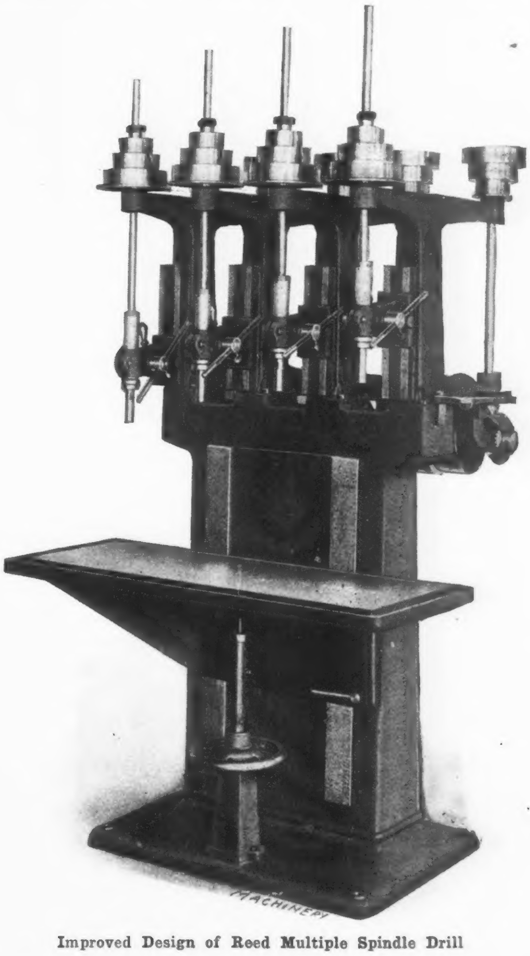
Fig. 4. Left-hand End of Roll Grinding Machine showing Arrangement of Motor Drive

One of these fixtures is permanently mounted on the footstock, where it is in a convenient position for dressing the wheel when it is engaged in grinding necks on the rolls. Another truing fixture is located on one of the bearings which carries the roll by its neck and is used when grinding the face of the roll. The third fixture is used for forming or rounding the corners of the wheel for grinding the fillets of the necks. This truing fixture is attached to the table of the machine.

It has already been mentioned that the rolls are supported by their necks in bearings while the body of the roll is being ground. These bearings have three points of contact which are adjustable for the variation which exists in the size of the necks due to wear and regrinding. They can be quickly removed and replaced by other bearings to accommodate a different size of roll. For grinding concave work, special bearings are required. These are provided with vertical adjustment for tipping the roll to an angular position with one end above and the other below the horizontal center line of the wheel. This results in a concave form being ground. The vertical adjustments of the ends of the work are controlled by screws, the amount of adjustment secured at either end being indicated by graduated scales. These bearings can also be used for grinding straight rolls and the arrangement of the pads is the same as described in the foregoing. The concaving outfit includes a universal driver for the work.

REED MULTIPLE SPINDLE DRILL

In the March, 1913, number of MACHINERY, the improvements made by the Francis G. Reed Co., 43 Hammond St., Worcester, Mass., in its line of bench drills, were illustrated and described. Since the completion of this work, the same attention has been given to the line of multiple spindle drills manufactured by this company, a four-spindle drill of the



Improved Design of Reed Multiple Spindle Drill

improved type being illustrated herewith. The general design of the machine has been retained, but various improvements have been made to adapt these machines for the most severe classes of modern manufacturing.

Among the changes which have been made, the following may be mentioned. All of the bearings have been lengthened and the length of the belts has also been increased to add to their driving power. The top cones have been brought down nearer to the frame of the machine to reduce the strain on the bearings, which are oiled through the top of the shafts. The swing has been increased to 14 inches, while the capacity remains the same; *i. e.*, up to ½ inch drills. Gear guards have been added which practically enclose all of the gears. A new material has been adopted for the bevel gears which is very tough and possesses excellent wearing qualities combined with the ability to give a practically

noiseless transmission. The drive is so arranged that there is only one belt for each spindle, this being a straight open belt.

It will be seen from the illustration that the column of the machine has been changed to the rectangular pattern, as in the case of the improved bench drills. The table bearings are made of ample length and the table is provided with a deep oil channel extending all the way around it. The table is supported and raised or lowered by means of a telescoping screw, a binder handle being provided to lock it to the column in any desired position. This improved type of machine is known as the Reed No. 300 multiple spindle drill.

HESS EDGE PROTECTORS

In lifting heavy, finished castings the edges are frequently damaged by the chain slings, this damage being due to both the indentations produced and to the result of the chain slipping on the casting. Where rope slings are used in place of chains, the damage to the castings is avoided, but at the expense of the ropes, which are soon worn out. Both of these difficulties are avoided by the edge protectors, illustrated herewith, which are a product of the Hess Steel Castings Co., Bridgeton, N. J. It will be seen that these protectors consist of a casting having two plate members at right angles to each other and a pair of stiffening ribs to

Fig. 1. End and Side Views of Hess Edge Protector

provide the necessary strength. The chain or rope rests between these ribs, the protector being thickened and rounded at this point to form a seat which will prevent the sling being damaged. The ribs are carried far enough back to receive a cotter pin which holds the protectors in place on the sling when they are not in use.

Provision is made against the slightest damage being done to castings with sharp finished edges by running a groove along the protector at the point where the two plate members join. This groove will be readily seen in the end view of one of the protectors, which is illustrated at *A* in Fig. 1, a side view being shown at *B*. The protectors are made of a very low carbon alloy, which is of essentially the same composition as pure wrought iron. This material is so ductile that there is no danger of the protectors being broken, even when they are subjected to the roughest handling. Where great care in handling is required, protectors are made with a babbitt or lead lining. This lining may be renewed as it becomes worn or charged with chips, suitable pouring dies

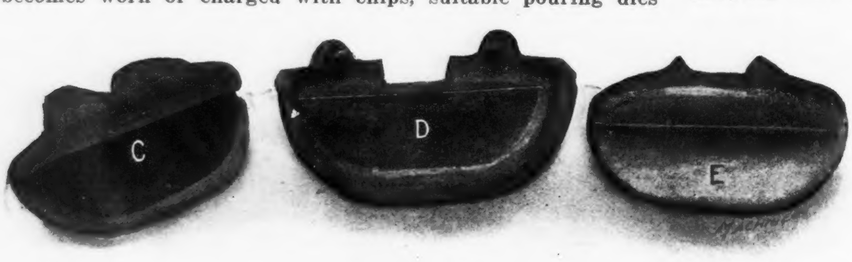
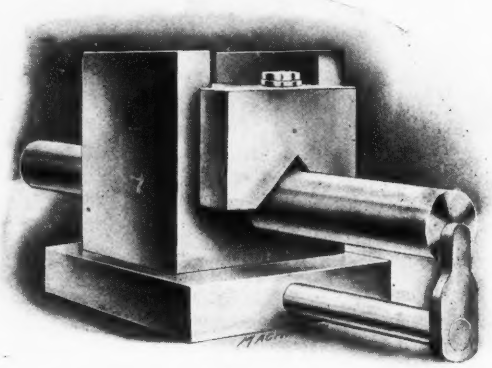


Fig. 2. Recessed Casting for Babbitt Lined Protector, Pouring Die and Finished Protector

being provided for the purpose. A recessed casting for one of these protectors is shown at *C* in Fig. 2; the pouring die is illustrated at *D* and the protector with the babbitt lining is shown at *E*. With guards of this nature, finished pieces of work can be handled without any danger of marring them.

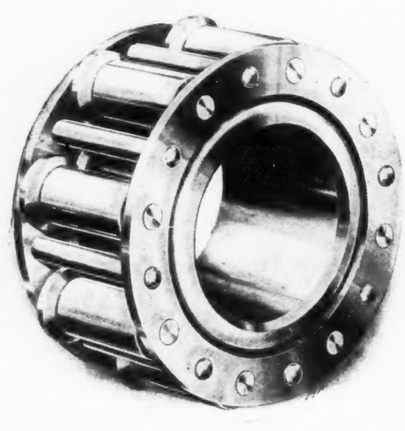
HOLTON V-BLOCK

The doublé V-block illustrated herewith is a product of the Holton Co., Jackson, Mich. This is a particularly useful drill press tool, and with it holes can be drilled perfectly straight through a bar, no special skill being required for the operation. The block is made of cast iron, accurately milled by means of special milling cutters designed for the purpose. The master bushing is made of steel and fitted into the upper V-block. This bushing is hardened and ground to



Holton V-block for holding Work to be drilled

¾ inch inside diameter and pressed into place. Interchangeable bushings are provided which fit into this master bushing and adapt the V-block for the use of different sizes of drills. The interchangeable bushings are also made of steel, hardened and ground in the customary manner. A set of ten interchangeable bushings forms a part of the regular equipment of these V-blocks. Referring to the illustration it will be seen that the V-block is equipped with an adjustable gage



Bower Roller Bearing for Combined Radial and Thrust Loads

which makes it a simple matter to produce duplicate pieces. The capacity of the V-block is for pieces ranging from ¼ inch to 2 inches in diameter.

BOWER ROLLER BEARING

The Bower roller bearing illustrated herewith is adapted for carrying combined radial and thrust loads, but the two components of the load are carried by individual bearing members. In this particular, the design of the Bower roller bearing differs from most forms of roller bearings designed for such service. The rollers used in this bearing consist of a long cylindrical portion upon which the radial load is supported. At one end of the cylindrical portion of each roller there is a flanged head; this head fits into corresponding grooves in the races of the bearing and the thrust load is supported upon the inclined faces shown at the left in the halftone. The heads which receive the thrust load do not come into contact with the radial raceway and therefore do not support any portion of the radial load. As the radial and thrust supporting members of the bearing are independent of each other, an increase of either radial

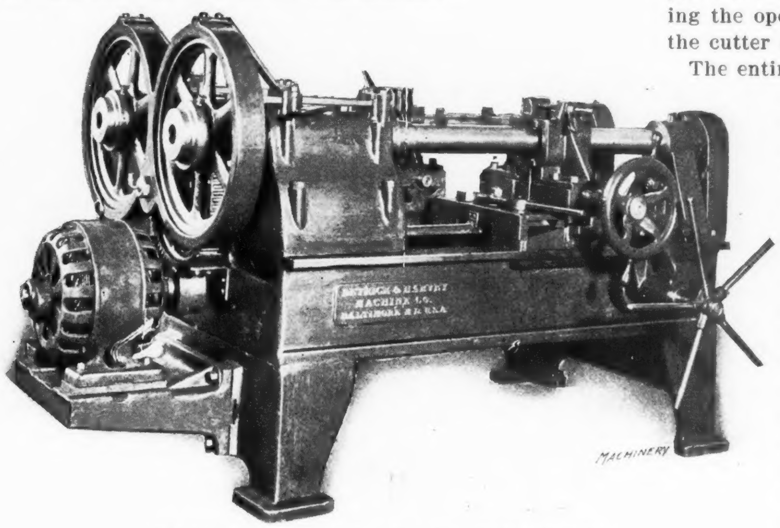
or thrust load does not affect the efficiency of the bearing for carrying the other kind of load for which it is designed.

This bearing is absolutely non-adjustable as regards radial alignment, but the end play in the bearing may be increased or diminished to suit individual requirements without in any way affecting the alignment of the shaft or spindle. Owing to the self-aligning principle which is employed, the rollers always run in a parallel path without any wedging action, and it is stated that, when correctly mounted and of the proper size, the bearing will run for years without appreciable wear. The rollers are freely mounted at one end and held at the other end by means of the heads which carry the thrust load. This bearing is manufactured by the Bower Roller Bearing Co., Detroit, Mich.

DETRICK & HARVEY BORING MACHINE

The duplex boring machine illustrated herewith is a recent production of the Detrick & Harvey Machine Co., Baltimore, Md. This machine was designed for machining car boxes, and the bed is of sufficient length to enable boxes 6 inches in diameter by 12 inches in length to be bored and faced.

The spindles of this machine are made of cast iron; they are 4¼ inches in diameter and run in bearings 17 inches in length. The spindle bearings are capped. Sliding tooth clutches keyed to the spindle and actuated by an eccentric lever engage or disengage toothed sleeves which revolve loosely on the spindles. The driving gears are made of cast iron and the pinions of either bronze or steel. The boring bars are secured to sockets in the ends of spindles and are supported at their outer ends by bearings; the two spindles can be operated simultaneously or independently as desired. The bars have no movement longitudinally.

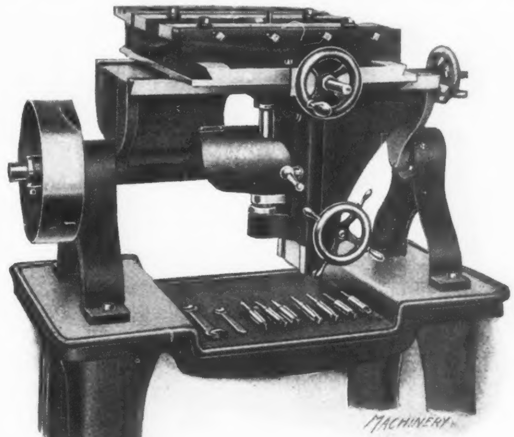

Detrick & Harvey Duplex Car Box Boring Machine

The carriages are fitted to the inner locks of the shears and are moved longitudinally by hand or power. A quick hand movement operated by the spider shown in the illustration is provided by means of the rack and pinion, while a slow hand movement is provided by means of the handwheel. Power feeds are provided by spur gearing at the end of the bed farthest from the headstock. Each carriage contains a square locked cross-slide upon which two slides are fitted, the slides being adjusted to and from the center line of the spindle by a screw, as shown in the illustration.

The change gears are located at the end of the machine farthest from the headstock. Motion is transmitted to the feed mechanisms from their respective spindles so that the feed is only in action while the spindles are revolving. Each spindle is provided with independent feed changes. The feeds to the carriage cover a range of from 1/16 to 3/16 inch per revolution of the spindle. The spindles are driven by a 12½ H. P. motor which has a speed variation of 1 to 2 and gives spindle speeds from 25 to 50 revolutions per minute. It will be seen that the motor is mounted on a bracket at the head end of the machine so that the unit is entirely self-contained.

THURSTON DIE MILLING MACHINE

The Thurston Mfg. Co., Providence, R. I., has recently redesigned its die milling machine, a number of improvements having been incorporated in its construction which add materially to the efficiency of the machine. The illustration shows the redesigned machine, and, as in the preceding type, the die to be milled is held on a table which is carried by cross

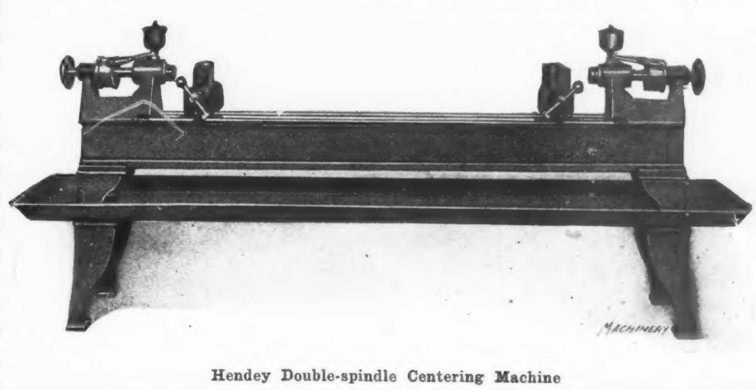

Improved Design of Thurston Die Milling Machine

and longitudinal slides. The cutter spindle projects upward through the die opening, and by manipulating the handles which operate the two slides the work is fed against the milling cutter until it has been recessed to the desired shape. Taper cutters are used, a suitable taper being employed to provide the clearance that is required for the die. In starting the operation, a hole is drilled in the die-block in which the cutter starts to operate.

The entire frame is mounted on trunnions so that the work may be inclined to the position which is most suitable for the operator. In the original machine, the cutter spindle was simply mounted in small brackets, but in the redesigned machine the cutter spindle is supported by a slide having broad bearing surfaces so that it is rigidly held; this slide also facilitates the adjustment of the position of the cutter. The raising and lowering of the cutter-slide is accomplished by means of a handwheel. The handwheels which control the cross and longitudinal movements of the work-table, are fitted with adjustable collars which provide for compensating for wear, so that backlash may be entirely eliminated. The spindle has been made much heavier than in the preceding type of machine and runs in taper bronze bushings which are carefully protected from chips and dirt. The construction of the machine has been made heavier throughout, so that it is better adapted for the heavier classes of work for which it is used.

HENDEY CENTERING MACHINE

For some time past, the Hendey Machine Co., Torrington, Conn., has been manufacturing single-spindle centering ma-


Hendey Double-spindle Centering Machine

chines. In order to enable a shaft to be centered at both ends by a single operation, this company has developed the

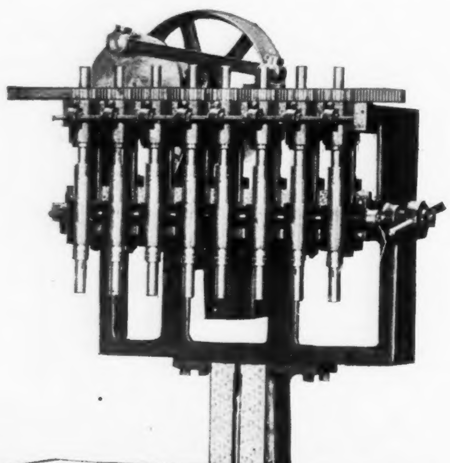
double-spindle machine illustrated herewith. The design has been worked out along the same general lines followed in the construction of the single-spindle machines, but several noteworthy improvements have been made.

The heads are rigidly clamped to the bed, thus affording permanent alignment for the spindles. The spindles run in ample bearings which are equipped with felt oilers; the front journals are made taper and have ball thrust bearings for carrying the end load. The spindles carry draw-in attachments with watch tool chucks for accurately holding combination center drills and reamers. Back locking pins working in the flanges of the pulleys are provided for use when it is necessary to remove or replace the center drills. The vise jaws are made of hardened and ground steel. The alignment of the spindles and jaws is obtained by means of a proof bar carried in the spindles. This care in providing for the alignment of the work is necessary in order to enable the machine to center stock accurately for finishing operations after it comes from the turret lathe or screw machine. No matter what the diameter of the bar may be within the limits of the machine, it will always be supported in a horizontal position.

The incline surface on the bed, sloping away from the operator, tends to direct the chips into the pan rather than have them accumulated around the heads and necessitate a frequent cleaning before being able to shift the vise carriages. Heavy parallel bars running the length of the machine serve as a rack for holding stock which is to be centered. The capacity of the machine is from 5/16 inch to 4 inches inclusive.

FOOTE-BURT MULTIPLE SPINDLE VALVE GRINDER

The adjustable multiple spindle oscillating valve grinder which is illustrated herewith is a product of the Foote-Burt Co., Cleveland, Ohio. This machine was designed for use in



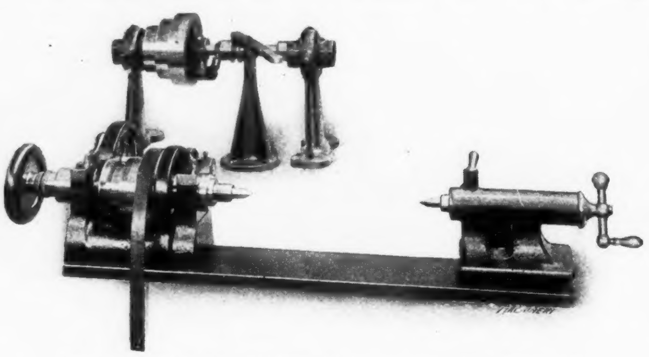
Foote-Burt Multiple Spindle Oscillating Valve Grinder

the manufacture of automobile engines and enables a complete set of valves to be seated in less time than is ordinarily required to seat one valve by hand. The spindles reverse at every one and one-quarter revolution and a cam is provided on the machine which raises and lowers the spindles at intervals of twenty revolutions to allow the grinding compound to enter the valve seat.

Machines of this type are built with from two to twelve spindles, depending upon the type of cylinder, and the spindles are made adjustable, the minimum center distance being two inches. The spindles are arranged with a ball thrust bearing on each end of the bearing and have a travel of 2¼ inches. The spindle noses are No. 1 Morse taper. The table may be adjusted up and down to enable the machine to handle different sizes of cylinders, making it sufficiently flexible to handle any type of cylinder, the valves of which might suitably be seated on this machine.

DAVIS MAGNET WINDING MACHINE

The W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y., has recently added to its line the machine shown in the accompanying illustration which is used for winding



Davis Machine for winding Electromagnets for Automobile Self-starters

electromagnets for automobile self-starters. It will be seen from the illustration that this machine is equipped with a back-geared head and that the nose of the spindle is threaded left-hand; also that the rear end of the spindle is provided with a handwheel which is used by the operator for starting work and for making corrections.

The spindle is driven by a countershaft placed on the bench at the rear of the machine. This countershaft has a friction clutch in the cone which is so adjusted that it will slip when the brake is applied. The brake consists of a strap, shown in the illustration, which runs over the large step of the cone pulley and is actuated by means of a foot treadle. Machines of this type are built in four sizes, an 11-inch, a 14-inch, a 16-inch and an 18-inch size. The illustration shows the 11-inch machine.

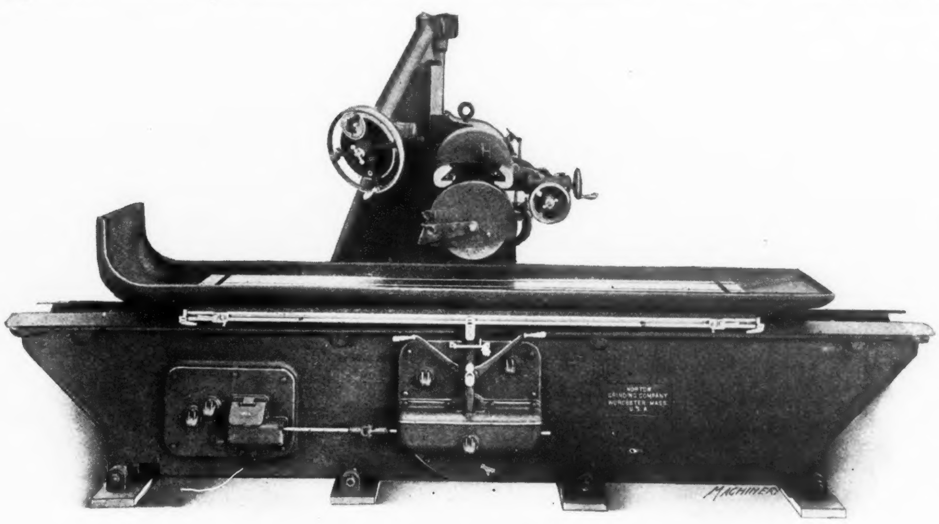
NORTON OPEN-SIDE GRINDING MACHINE

Experience has shown that in the operation of grinding wheels, the smaller the arc which is in contact with the work, the more efficient the operation of the wheel becomes, and as a result it is advisable to use wheels of small diameter. This is especially necessary when grinding plane surfaces, as the arc of contact in such cases is much greater than when round work is being ground. With a large arc of contact, the opportunity for the chips to escape is reduced. This results in heating, undue power consumption, and general inefficiency. When, for any reason, the chips cannot escape freely, a satisfactorily finished surface cannot be produced.

The open-side grinding machine illustrated herewith is a recent product of the Norton Grinding Co., Worcester, Mass. This machine is designed for grinding plane surfaces, and in order to attain the most satisfactory results, the periphery of the smallest wheel that is practical for the work in hand is used. The machine is designed to carry wheels 14 inches in diameter and for the usual class of work handled the wheel should have a 6-inch face. For special work, wheels of different widths can be used. The working surface of the table is 15 inches wide and is made in lengths of 6, 8, 10, 12 and 14 feet. The wheel head can be raised so that the distance between the surface of the table and a 14-inch wheel is 17 inches; this provides for the use of a magnetic chuck

or supplementary table when necessary. The countershaft is located in the machine base, so that the machine is self-contained. Power is transmitted to this countershaft by a belt running from the motor which is placed at the side of the machine. It will be evident from this description that all overhead works are eliminated. A 15 horsepower motor provides ample power for the requirements of ordinary work.

The grinding wheel is carried on a cross-slide operating at right angles to the travel of the table, and in order to secure the high rate of production that is made possible by the wide wheels used on this machine, no automatic feed of the wheel has been provided. A hand traverse has been designed for locating the grinding wheel in order to utilize the full width of the wheel face. Provision is also made for a slower traverse of the wheel when truing its face, this traverse being obtained through worm-gearing. The cross-slide is carried on a vertical slide, which is raised and lowered on the column by means of a ½ horsepower motor. For small distances, the vertical traverse is obtained by means of a handwheel on a shaft geared to the vertical traverse screw, and a micrometer index, which reads in quarter-thousandths, provides for making delicate adjustments.



Norton Open-side Grinding Machine for Plane Surfaces

The table is provided with T-slots of standard dimensions, which facilitate strapping work to the table or the application of a supplementary table, special fixtures or a magnetic chuck. The table traverse is obtained by means of worm-gearing which affords a perfectly uniform motion that is essential for the production of smooth, accurate work. The reversal of the table is pneumatically cushioned at the ends of the stroke. All kinds of plane surfaces which are within the capacity of the machine can be quickly and accurately ground. The machine can also be used for grinding surfaces of a variety of shapes, and for this class of work a special forming attachment is used to form the wheel to produce the shape required.

Ball bearings are employed on all shafts operated by handwheels and the worm and worm shafts are provided with ball thrust bearings. All of the worm-gearing runs in oil. The worms and wheel spindle are made of chrome-nickel-vanadium steel and all shaft bearings are ground to run in self-oiling boxes. Special equipment is used in scraping the ways in the base, which results in such accuracy of alignment that when the table has been ground in place, it presents a neat and uniform surface free from chatter marks. The inspection to which the machine is subjected requires a B. & S. straightedge the length of the finished table surface to hold pieces of tissue paper two inches apart throughout its length, with the straightedge laid at any angle on the table. The machine is supported on adjusting wedges mounted on iron plates which are imbedded in a concrete foundation; this makes it possible to realign the machine easily should such a procedure become necessary. A large tank is provided with a pump which will deliver thirty gallons of lubricant per minute to the wheel and work.

PRATT & WHITNEY 22-INCH VERTICAL SURFACE GRINDER

For several years the Pratt & Whitney Co., Hartford, Conn., has been manufacturing a small size of vertical surface grinder. The results obtained with this machine were so satisfactory that it was decided to build a larger machine along similar lines which would be suitable for heavier classes of work. The result of this undertaking is shown in Figs. 1 and 2 which illustrate front and rear views of the 22-inch vertical surface grinder which has recently been placed on the market by this company. While the design adheres to the general lines of the smaller size, the machine has been improved in many respects in order to adapt it for the severe service which is required of a grinder engaged on modern manufacturing work. Every refinement which experience has demonstrated to be essential for a machine of this type has been incorporated in the design, and although of unusual dimensions, the machine is a precision tool in every particular. It is very sensitive and easy to operate, all of the operating mechanism being contained in a single unit which is conveniently situated for the operator.

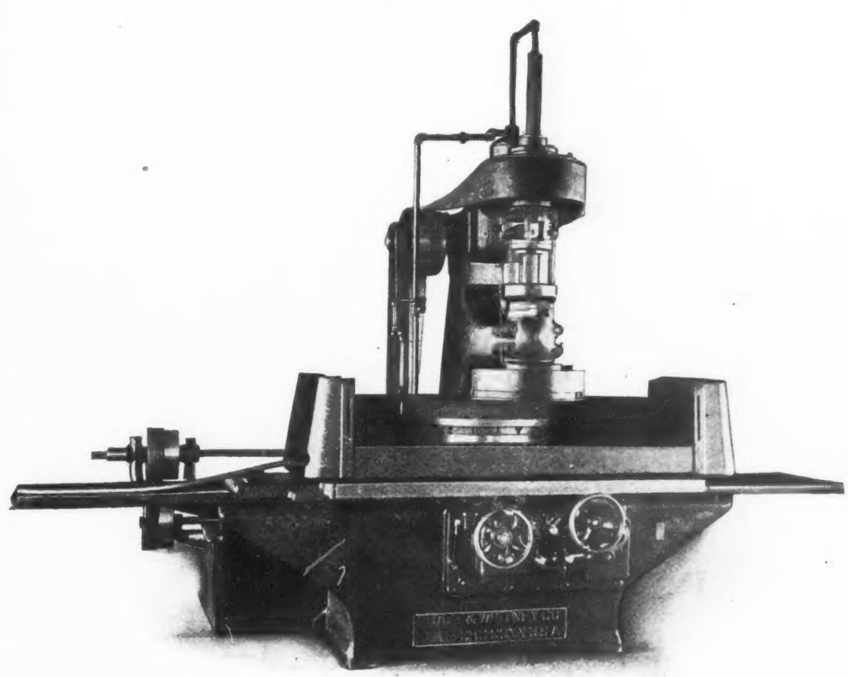


Fig. 1. Front View of Pratt & Whitney 22-inch Vertical Surface Grinder

The bed is provided with wide bearing surfaces of the vee and flat type, oil reservoirs being located in the bed for oiling the ways by means of rolls. The pan which surrounds the rear of the bed for collecting the water and receiving the chips is of liberal proportions and easily accessible for cleaning. The machine may be regularly furnished with either 4- or 7-foot tables, the bed being made in two lengths to accommodate these sizes; both the bed and table are finished perfectly true by means of masters. The table is provided

with guards which protect the bearing surfaces at all times from injury. A spacious pan is cast integral with the table for controlling the water and chips. The upright is bolted solidly to the bed, wide bearing surfaces being provided for the accommodation of the head. A taper gib forms part of the construction which makes it easy to maintain the proper relation between the head and the upright bearings. The bearing surfaces are also protected by means of very efficient wipers and guards.

The spindle is made of special steel, proportioned to resist the peculiar strains to which it is subjected. Attention is directed to the fact that the spindle is of ball bearing construction throughout. This also applies to the driving pulley which is mounted on ball bearings that are independent of the spindle. Thus the pull of the belt is absorbed by this independent bearing and is not transmitted to the spindle. This is a most important feature, without which it is practically impossible to design a head that will operate sensitively or retain its accuracy for any length of time. Furthermore, this construction places the driving belt in a protected position away from the water spray, so that it does not lose its efficiency by becoming moist. The ball bearing construction has been subjected to exhaustive tests and has proven efficient in every particular. With its use the loss through friction is reduced to a minimum and practically the entire power is utilized for driving the wheel.

The table is provided with an automatic reciprocating motion, any desired length of stroke being readily obtainable by means of adjustable table dogs. The feed mechanism is of a most efficient and substantial construction which is contained in one compact unit. The table is driven through a rack and pinion, the construction eliminating the possibility of vibrations (commonly called tooth marks) showing in the work. Two table feeds are provided, both of which may be instantly controlled through the lever *A* shown in Fig. 3. When adjusted to the right-hand station, the slow feed is engaged; and the left-hand station engages the fast feed in a similar manner. This lever, when adjusted to the central station, also serves as a means for stopping the table. The table, in addition to the two feeds mentioned, is also provided with power quick return for use in connection with rotary chucks. The power quick return becomes operative and the regular feed inoperative by moving lever *B* to the lower station. It will be noted, however, that the lever *B* is locked by means of a lock-bolt *C* and cannot be operated while the regular feed is engaged. In order to unlock lever *B*, it is necessary for the regular feed lever *A* to be in the neutral position, after which the lock-bolt *C* may be adjusted to its outward position, which has the effect of releasing lever *B* and locking lever *A*. Thus it is impossible to engage both the regular and quick return feeds at the same time. After the quick return mechanism has become operative it is controlled through lever *D*.

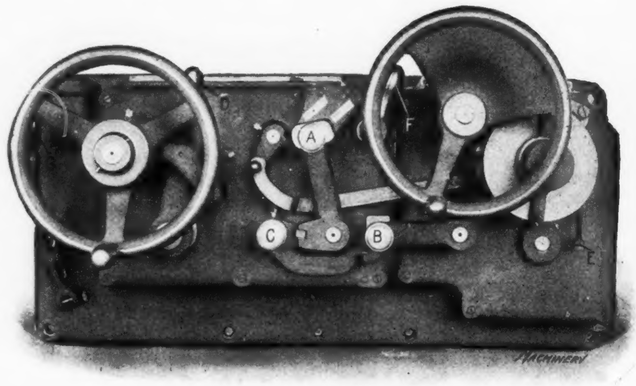


Fig. 3. Control Mechanism of Table Feed on Pratt & Whitney Surface Grinder

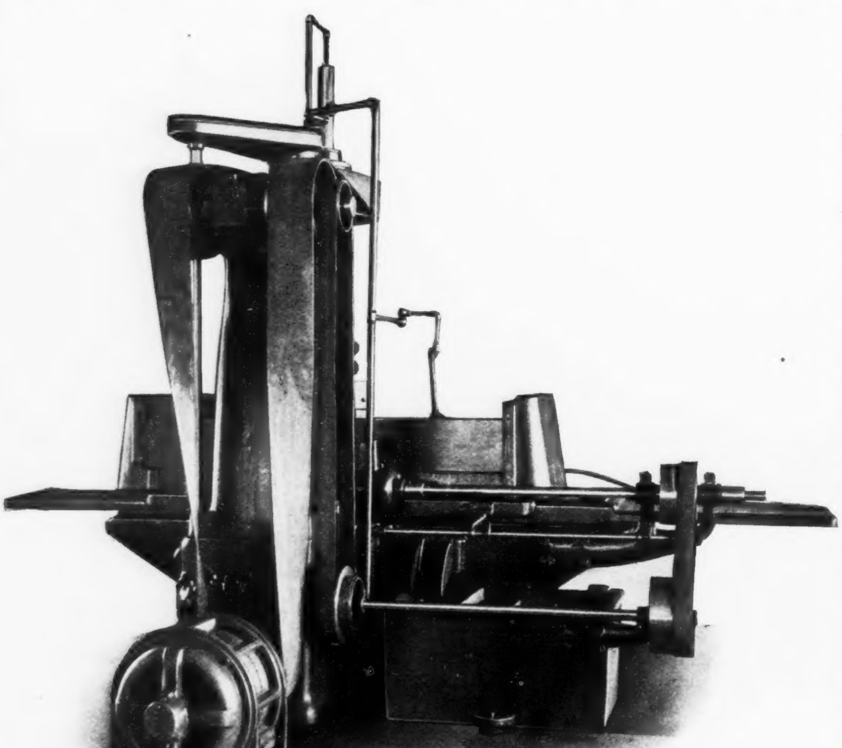


Fig. 2. Rear View of Pratt & Whitney 22-inch Vertical Surface Grinder

The wheel is provided with both hand and power feeds in addition to the rapid hand feed. The vertical adjustment is very sensitive, the head being perfectly counterbalanced and very accurately controlled through the feed mechanism. The power feed is operated through a ratchet wheel and pawl, the rate of feed being controlled by means of the adjusting screw *E*. A large micrometer dial for gaging purposes and also an automatic power feed knock-off forms part of the construction. Both the regular and rapid hand feeds are controlled through the lever *F*. This lever is operated in and out; when adjusted to its inner station, the regular hand feed is engaged, the outer station engaging the rapid hand feed. The design is such that when the rapid feed is engaged the power feed is automatically disengaged and cannot be used. The reason for this precaution is that the rapid feed is altogether too fast to be used when the machine is in operation, and if the power feed should become engaged through error the wheel would be broken. The machine is designed for motor drive only, the method of mounting the motor directly on the floor being clearly shown in Fig. 2. Provision has also been made whereby the correct belt angle from the idler to the motor pulley may be always maintained, irrespective of the diameter of the motor pulley. This is accomplished by means of the left-hand idler pulley which is so mounted that it may be swiveled to the correct angle, after which it is permanently doweled in place. The size of the motor varies from approximately 20 to 35 horsepower, according to the nature of the work for which the machine is to be used. A constant-speed motor is used, running at approximately 1200 revolutions per minute.

The machine is provided with a pump of new design which is capable of supplying an abundance of water. One stream of water is carried through the spindle, the centrifugal force of the spindle driving the water between the wheel and the work, and thus keeping both cool and free from dust. The inside stream of water is controlled through the lever *G* which is conveniently located on the front of the gear-box unit. An outside stream is also provided for conveying water to the outside of the wheel and for cleansing purposes. The wheel guard also assists in controlling the water. An exceptionally large tank is located on the back of the machine in an accessible position where it may be readily cleaned. The water is returned to the tank without being carried through pipes; in fact, the design is of such a nature that the collection of dirt or grit in inaccessible places is impossible.

Special attention has been given to the lubricating problems involved and large self-feeding oil reservoirs are provided which insure an ample supply of oil at all times. All bearings are absolutely dust- and water-proof.

A most important factor in the productive capacity of this type of machine is the cup-shaped wheel which covers the full width of the work, insuring perfect flatness, together with the greatest possible production. The wheel is protected by means of a guard, the guard being so mounted that it may be conveniently adjusted for height as the wheel wears. A wheel band is also furnished which should at all times be used upon the wheel.

The rectangular magnetic chuck affords a convenient appliance for holding a large variety of work; it may be readily applied to the table and is of water-proof construction throughout, so that water may be freely used without any danger of short-circuiting. The rotary chucks have been designed with a view of attaining the maximum efficiency as regards durability, accuracy and power consumption. They are absolutely dust- and water-proof, the drive units being located outside of the water guard, making it impossible for water to get into the chucks. The driving mechanism is so designed that it engages automatically when the chuck is brought in under the wheel and disengages when it is removed to be reloaded. The chucks are lubricated throughout by means of two large self-feeding oil reservoirs. The single rotary chuck is made either plain or magnetic. It is designed so that it may be tilted, permitting the grinding of either concave or convex surfaces. This is a desirable feature on a large variety of work, such as circular saws, cutters, and similar parts.

Special attention is directed to the duplex and quadruplex chucks which have recently been developed for use in connection with the Pratt & Whitney vertical surface grinders. Their value can readily be appreciated, as it is obvious that on work within their range the productive capacity of the machine has been practically doubled and quadrupled. A double chuck possesses all the features of the single chuck, in that it can be tilted to permit grinding concave and convex surfaces, or it may be adjusted to grind perfectly flat. The adjustment for each of the chucks is independent and when necessary they may be adjusted horizontally and reground to absolute accuracy. This chuck has proved very efficient in grinding saws and cutters with concave surfaces and is equally well suited for convex or flat surfaces. The quadruplex chuck is always horizontal and non-adjustable; thus it is only suitable for grinding flat work and will not handle concave or convex surfaces. The quadruplex chuck is by far the fastest on work such as gear blanks, washers, disks, etc.

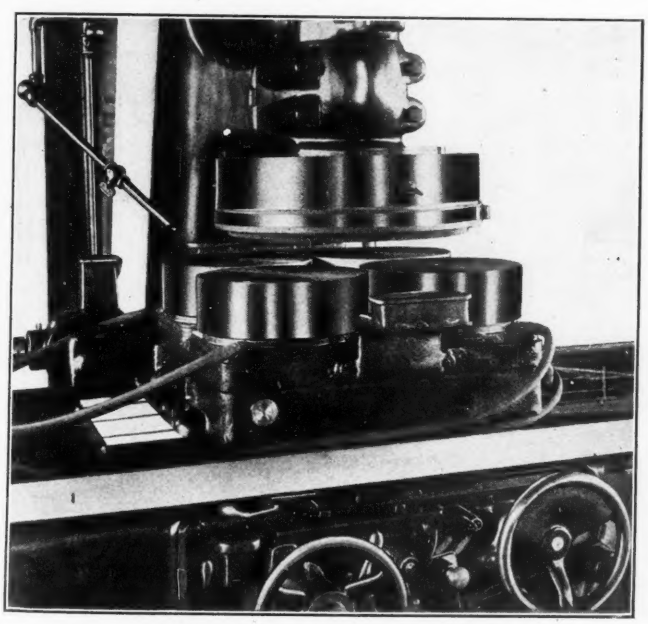


Fig. 4. Arrangement of Multiple Chucks on Pratt & Whitney Vertical Surface Grinder

LANGELIER DRILL FOR ROLLER BEARING CAGES

A special design of multiple spindle drilling head, which is illustrated in Figs. 1, 2 and 3, has been developed by the Langelier Mfg. Co., Providence, R. I., for use in drilling roller bearing cages for motorcycles. These cages, one of which is shown in Fig. 4, have eleven roller seats 0.255 inch in diameter, which are spaced equidistant from each other around a pitch circle 1⅛ inch in diameter. The comparatively large size of the roller seats that had to be drilled on this small circle made the spacing of adjacent holes so close that it was impracticable to drill the eleven holes at one operation and at the same time retain a sufficiently strong spindle construction to enable the head to operate satisfactorily. As the layout contained eleven holes, the drilling could not be done in two operations with an ordinary multiple spindle drilling head. The head was, therefore, designed for drilling the eleven holes in three operations and to work simultaneously on three roller cages.

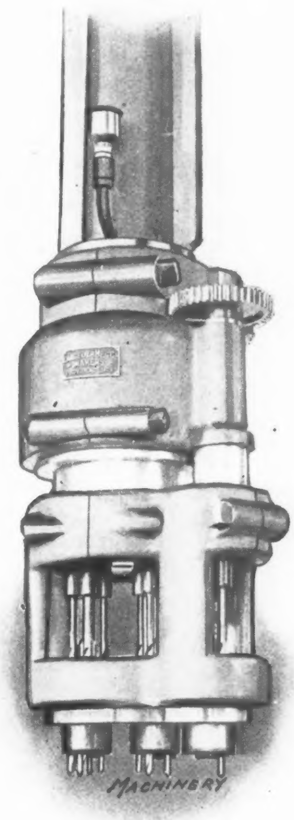


Fig. 1. Side View of Langelier Drill Head

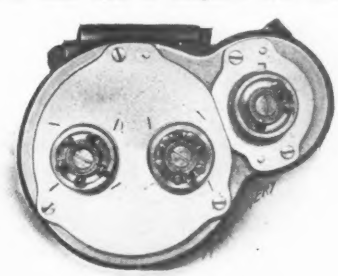


Fig. 2. End View of Drill Head showing Arrangement of Spindles

The head used for this purpose is attached to and driven by an automatic dial feed drill press having power feed and quick return to the head. The machine has a turret indexing table containing twelve chucking stations evenly spaced around a circle 9.658 inches in diameter, in which the cages to be drilled are placed by the operator. The two groups of five multiple spindles and the auxiliary spindle for drilling the eleventh hole are located in the head on an arc of a circle corresponding to the circle on which the chucking stations of the indexing turret are located. As the work in the turret indexes clockwise 1/12 of a revolution after being operated upon by the first drill head, it comes under the second head, which drills five more holes; it is then indexed a second time, bringing the work under the auxiliary spindle, which drills the eleventh hole in the cage. The eleven holes are thus drilled in three operations, which are carried on successively until one cage has been completely drilled. While these operations are going on the operator has ample time to take out the cages and put in fresh blanks.

The chucking stations in the dial feed table hold the cages freely and allow a pilot to enter the bore of the cages ahead of each set of spindles, thus bringing the work into the desired alignment. The pilots for the second group of spindles, and for the auxiliary spindle, have a number of steel locating pins which project from the drill bushings and enter the holes drilled by the first operation before the second and

third operations take place. In this way, the holes drilled in the second and third operations are properly located in relation to the holes already drilled in the cages. In Fig. 1 the drills are shown projecting from the pilot simply to show where they pass through, but while clear of the work the drills are beyond the base of the pilot, as shown in the sectional view of the drill head which is presented in Fig. 3. The multiple head consists essentially of a substantial cast-iron housing which is made to clamp around a special form of saddle on the automatic drilling machine and designed to clamp tightly over a phosphor-bronze spindle head. The spindles are located on fixed centers; they are machined from solid alloy tool steel and provided at their lower ends with chucks especially designed for receiving straight shank tanged drills. Bronze and steel washers for receiving the upward thrust are used to eliminate sliding friction as much as possible. The balance head is forged integral with the main spindle of the automatic drilling machine. The auxiliary spindle at the right is driven from a cut steel gear mounted on the main spindle of the machine through an intermediate fiber gear. The drill steadyrest with hardened

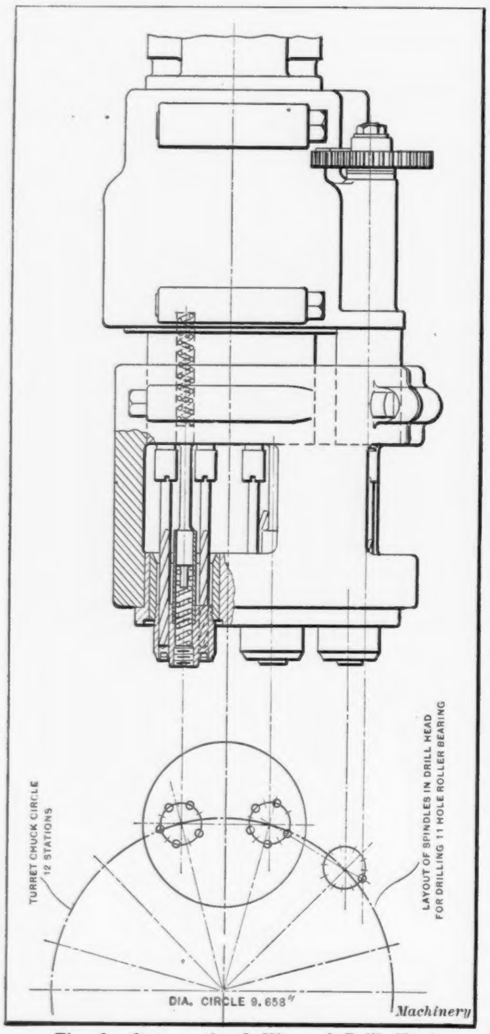


Fig. 3. Cross-sectional View of Drill Head

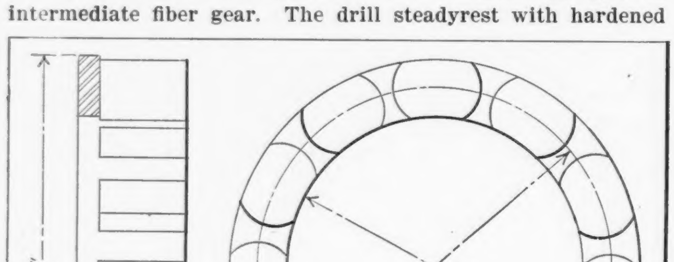


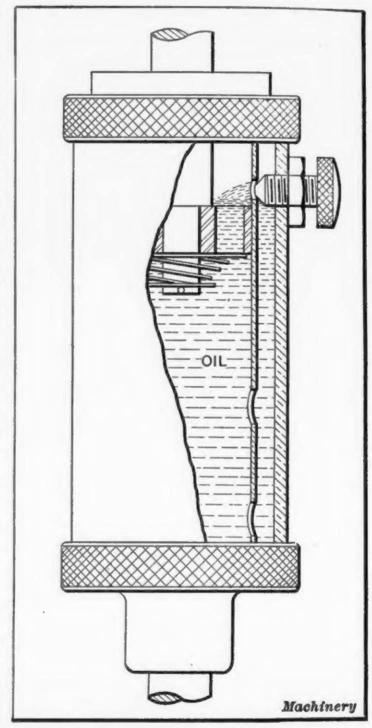
Fig. 4. Type of Roller Bearing Cage for which Langelier Drill Head was designed

and ground steel guide bushings is clamped to the lower end of the drill head and supports the drills close to their cutting end to insure having them start accurately. The drills project from the guide bushings just enough to penetrate the cage to be drilled. In order to compensate for the shortening of the drills due to grinding, the drill steadyrest may be adjusted up or down over the spindle boring head.

BOWDLE PUNCH PRESS SAFETY DEVICE

Power presses are generally recognized as one of the most dangerous forms of equipment used in industrial plants, and various forms of safety devices have been developed for the protection of operators of this class of machinery. The accompanying illustration shows a punch press safeguard which has recently been placed on the market by Bowdle & Co., 507 Jackson Blvd., Chicago, Ill., and it is claimed that this device will positively prevent the accidental tripping of a press. The device is connected to the rod which joins the treadle with the latch pin, a section of the rod being cut away at the point where the safeguard is attached. The illustration shows the interior construction of the device, with the different parts in position ready for operation.

The action of the safeguard may be briefly outlined as follows: A quick and decisive stroke of the treadle forces the cylinder upward, and this motion is transmitted through the oil to the piston, which, in turn, is forced up sufficiently to release the latch and allow the press to rotate. At the beginning of the pressure on the treadle, the oil starts to flow through the lower ports of the inner shell and then up through the by-pass, back into the cylinder on top of the piston. This releases the pressure below the piston, and by timing the flow of the oil by means of a cone valve in the by-pass, the piston and latch pin will resume their normal positions in time to disengage the clutch. This action is entirely independent of the action of the treadle, which may remain down. When the treadle is released, the cylinder drops back to the normal position and the oil passes down through the disk valve in the piston. In case the treadle should be pushed down in any ordinary way, instead of using a quick, decisive stroke, the oil will flow through the by-pass without imparting any motion to the piston. It is thus evident that the press can only be tripped by the deliberate act of the operator.



Bowdle Safety Device for Punch Presses

WHITCOMB-BLAISDELL TAPER TURNING LATHE

The illustrations show a lathe which has been designed by the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., with the idea of developing a machine for taper turning operations that is capable of producing work on a manufacturing basis. The design of the machine is simple. Referring to the illustrations, it will be seen that the carriage and tool-rest are carried on the outside bed, while the inside bed carries the headstock and tailstock of the machine. The inside bed swivels on a stud at the head end of the machine and is carefully fitted to the outside bed, being supported by a broad bearing at both the head and tail end and on a cross-tie member at the center of the machine.

This lathe swings 14 inches and is built with either 5-foot or 6-foot bed, the 5-foot bed taking 2 feet between centers. Particular pains have been taken to make this a rigid and durable tool adapted for manufacturing purposes. With this idea in mind, the outside bed has been made of the dimensions used for the regular 16-inch lathes of this company's manufacture, which have exceptionally large bearings. The inside or swivel bed is of corresponding proportions, so that ample rigidity is secured. Provision is made for adjust-

ment of the swivel bed through the adjusting screws shown at the tail end of the bed in Fig. 3. On a machine with a 5-foot bed the maximum taper that can be turned is 1.6 inch to the foot.

By locating the point about which the inside bed swivels

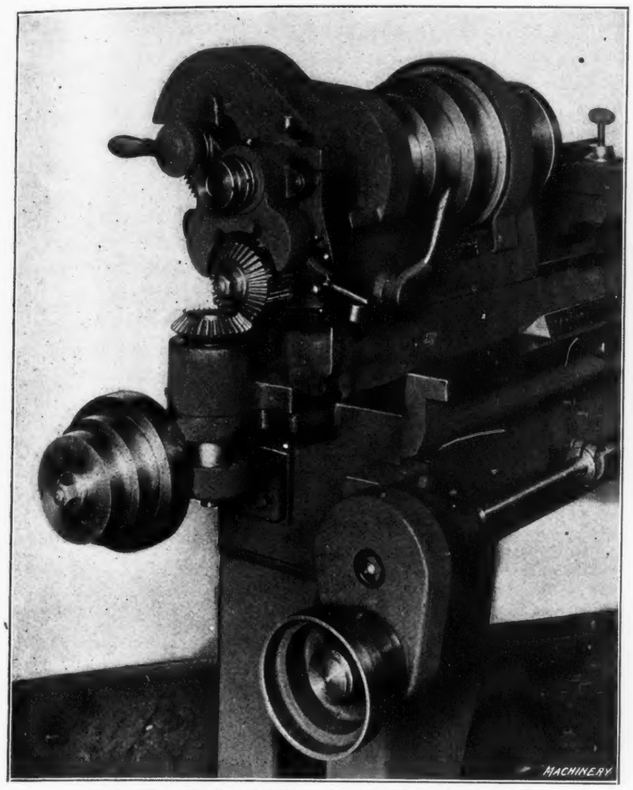


Fig. 1. Head End View of Taper Turning Lathe

at the head end of the machine, it is not necessary to change the length of the feed belt when changes are made in the feed. The feed mechanism is very simple, the feed being obtained through bevel gears and feed cones, the upper cone being driven by two spiral gears. Provision is made for adjusting the lower cone to allow for taking up the feed belt. When desired, the machine can be equipped with geared feed,

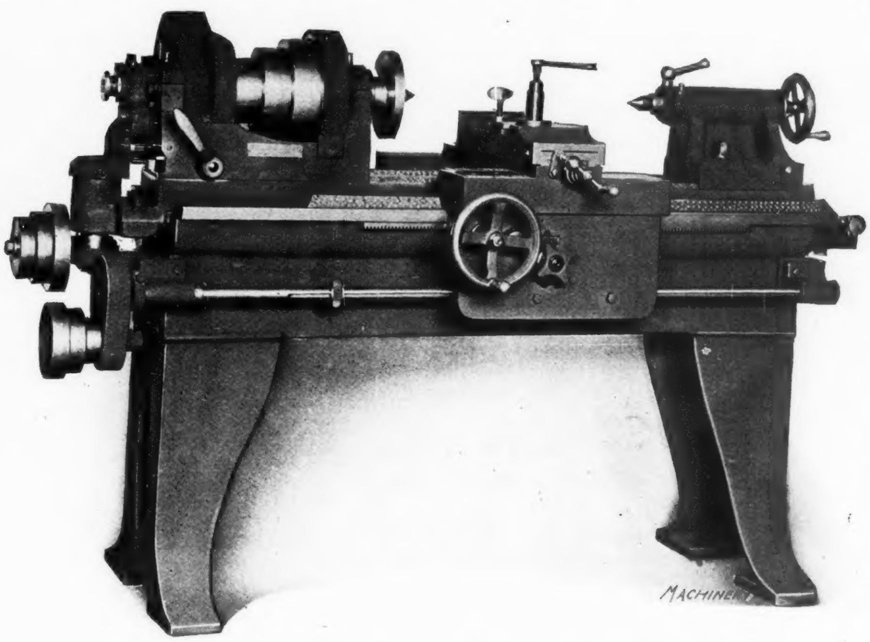


Fig. 2. Front View of Whitcomb-Blaisdell Taper Turning Lathe

providing three changes without substituting fresh gears.

The headstock on the lathe shown in the illustrations is of the three-step cone double back-geared type, giving nine spindle speeds in geometric progression. The back gears are locked in and may be shifted from the front of the machine. They are cut with a special involute cutter which gives a sharp pointed tooth, enabling them to be thrown in instantly. If desired, the machine could be furnished with a single pulley drive giving three changes through gears, the driving pulley being controlled by a powerful expanding ring friction. The tool-rest on the machine is of the elevating type which is the style regularly provided, although a plain gibbed block can be furnished if preferred. The rest is equipped with a screw gage for setting the tool, and the cross-feed is graduated to thousandths. The regular equipment

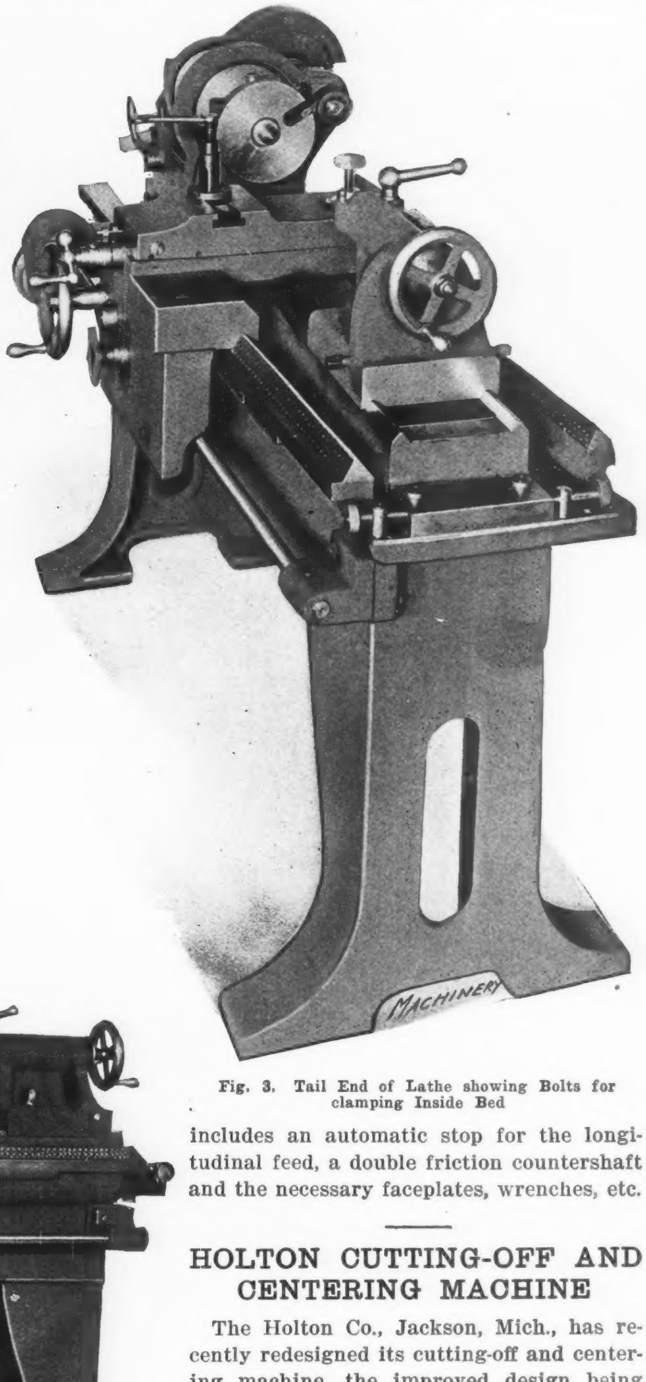


Fig. 3. Tail End of Lathe showing Bolts for clamping Inside Bed

includes an automatic stop for the longitudinal feed, a double friction countershaft and the necessary faceplates, wrenches, etc.

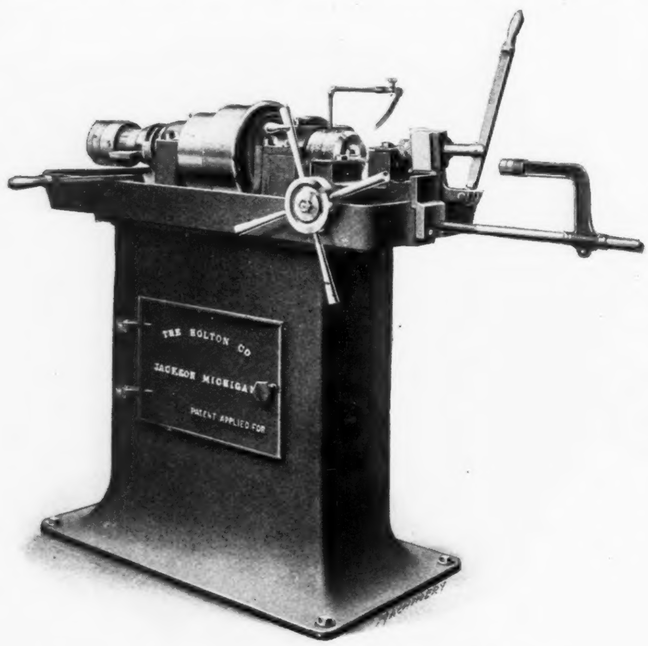
HOLTON CUTTING-OFF AND CENTERING MACHINE

The Holton Co., Jackson, Mich., has recently redesigned its cutting-off and centering machine, the improved design being shown in the accompanying illustration. The more important changes which have been made in this machine may be briefly outlined as follows: The column has been changed to the pedestal type which is more substantial and enables a tank for lubricating fluid to be contained inside the base of the machine. The improved machine has a single spindle which does away with all back gearing and a pilot wheel is provided in place of the handwheel formerly used, which enables the machine to be operated more rapidly.

This machine is designed for cutting off gas pipe, tubing and small bar stock and leaves the ends square and true. In cutting off tubing, the hole is left full size and without any burrs or other obstruction on the inside; consequently

it is unnecessary to perform a reaming operation after the stock has been cut off. Pipe or tubing can be cut to any length and as rapidly as if a rotary cutter were used. The spindle bushings are amply proportioned to insure rigidity and to withstand the most severe service to which a machine of this type should be subjected. The collets which hold the work are hardened and ground and are controlled by a lever which may be operated while the machine is working.

A new type of centering device is fitted to this cutting-off machine which makes it possible to handle centering operations most efficiently. The centering device can be attached or detached in about five minutes and if desired it may be left on the machine without interfering with cutting-off operations. The shaft to be centered revolves and the center drill and countersink are forced against it by a lever movement and then quickly withdrawn. By means of the same



Improved Type of Holton Cutting-off and Centering Machine

lever, the centering device may be drawn back on a hinged joint, leaving the front of the collet unobstructed. A long bar may be placed in the machine and pieces of any desired length may then be centered on one end and cut off. After the bar has been completely cut up, the pieces may be replaced in the collet and centered on the other end.

The oil reservoir is located directly beneath the table and can be easily cleaned by removing a plug from the bottom. The rotary pump which supplies oil or cutting compound to the tool is direct-connected to the shaft of the machine. The floor space occupied by the machine is 25 by 38 inches; the machine has a capacity for handling pipe ranging from 1/8 inch to 1 1/2 inch or for any size of stock up to 2 inches outside diameter. The net weight of the machine is about 950 pounds.

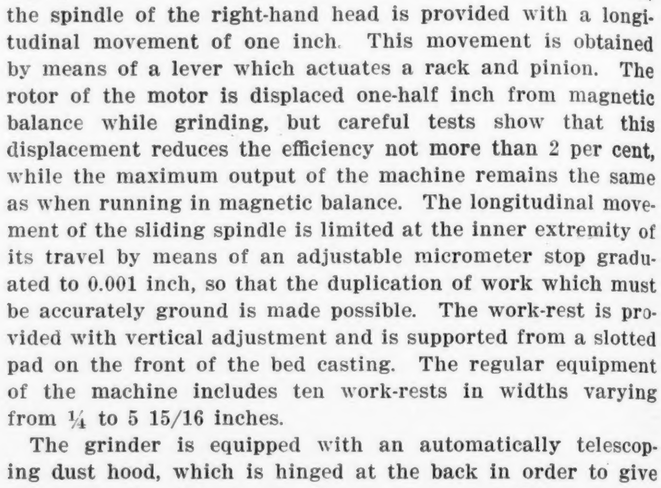
BESLY DOUBLE-SPINDLE DISK GRINDER

The illustration shows a motor-driven, double-spindle disk grinder which is a product of Charles H. Besly & Co., Chicago, Ill. This is a No. 6 machine and is equipped with 18-inch disk wheels. The double-spindle feature of this machine enables two grinding disks to be brought into contact with the work simultaneously, thus increasing the capacity and providing for grinding two surfaces of a piece exactly parallel. This type of grinder is largely used in the manufacture of wrenches, brass nuts, and for similar purposes.

The motors with which the machine is equipped are of the new pressed-steel type, which has recently been brought out by the Westinghouse Electric & Mfg. Co. These motors were described in the August issue of MACHINERY. The motors are bolted onto sub-plates, being clamped in position in a similar way to that used in securing the headstock and tailstock of a lathe. The motors develop 5 horsepower and are designed to operate at 1400 revolutions per minute on a 25-cycle, alternating-current circuit. Motors of this type can also be furnished to operate on a 60-cycle circuit. Machines equipped with these motors have disk wheels 20 inches in diameter and run at 1200 revolutions per minute, in order to give the proper abrasive speed. These disk grinders are not built with motors adapted for operation on direct-current circuits.

The left-hand head of the disk grinder is stationary, while the right-hand head can be moved along the bed by means of a gear and rack. After the head has been adjusted to the required position, it is clamped in place ready for the grinding operation. To bring the disks into contact with the work, the spindle of the right-hand head is provided with a longitudinal movement of one inch. This movement is obtained by means of a lever which actuates a rack and pinion. The rotor of the motor is displaced one-half inch from magnetic balance while grinding, but careful tests show that this displacement reduces the efficiency not more than 2 per cent, while the maximum output of the machine remains the same as when running in magnetic balance. The longitudinal movement of the sliding spindle is limited at the inner extremity of its travel by means of an adjustable micrometer stop graduated to 0.001 inch, so that the duplication of work which must be accurately ground is made possible. The work-rest is provided with vertical adjustment and is supported from a slotted pad on the front of the bed casting. The regular equipment of the machine includes ten work-rests in widths varying from 1/4 to 5 15/16 inches.

The grinder is equipped with an automatically telescoping dust hood, which is hinged at the back in order to give free access for changing the disks, and an air-tight connection in provided at the back of the machine for exhausting the grindings. The design has been worked out in such a way that a third wheel and rocker shaft may be attached to the left-hand end of the machine. A suitable work-table may be mounted on the shaft to serve the third grinding disk. The spindles are made of crucible steel and run in inserted bearing bushings of phosphor-bronze. The end thrust of the spindles is taken on hardened and ground steel collars, and the end play of the spindle is controlled by an adjustable keyed collar which is held in place by a lock-nut at the



Besly No. 6 Motor-driven Double-spindle Disk Grinder

end of the spindle. In the right-hand motor, both of the bearing bushings slide with the spindle and completely surround it; this construction reinforces the spindle when under load and protects it from emery dust. The spindle and thrust bearings are lubricated by grease from compression oil cups. The oil grooves are so placed that the oil is forced to the points where it is needed by positive feed. The movement of the grease is always outward, thus preventing grit from entering the bearings.

The geared lever feed on the sliding spindle gives the operator a leverage of 20 to 1, so that he may force the machine to the limit of its driving power without undue muscular exertion. The lever is clamped to the stud which carries the pinion engaging with the feed rack. This is an important feature of the design, because the lever may be clamped onto this stud is just the position which makes it most handy for

the workman. It is particularly desirable for this type of disk grinder to be driven by a direct-connected motor, because it is necessary to use a very large and heavy countershaft when belt drive is applied. The large size of the countershaft is mainly due to the fact that it is necessary to provide a drum pulley long enough to accommodate the full longitudinal adjustment of the movable grinder head. The countershaft employed for this size of grinder, when belt driven, is 96 inches long and weighs over 700 pounds. By using motor drive, all of these overhead works are naturally done away with. The important dimensions of the machine are as follows: Maximum opening between disk wheels, 10 inches; floor space occupied, 24 by 58 inches; weight, 2600 pounds.

CINCINNATI GEAR CUTTING MACHINE

Figs. 1 and 2 show front and rear views of the No. 7 Cincinnati automatic gear-cutting machine which has recently

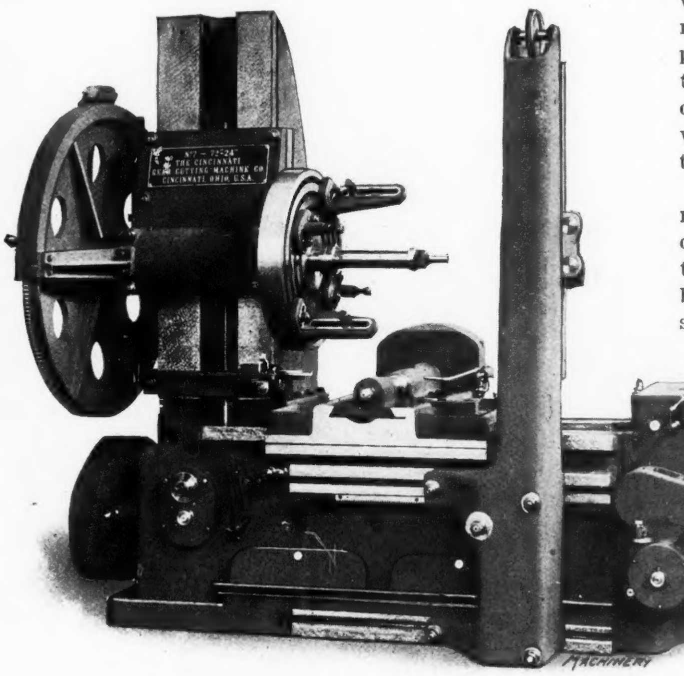


Fig. 1. Front View of Cincinnati Automatic Spur Gear Cutter

been brought out by the Cincinnati Gear Cutting Machine Co., Elam St. and Garrard Ave., Cincinnati, Ohio. This machine is designed for cutting spur gears and has a capacity for gears 72 inches in diameter by 24 inches face, being rated for cast-iron gears up to 1 diametral pitch and steel gears up to 1¼ diametral pitch. This machine is also built to cut gears 84 inches in diameter with the same face width and pitch ratings.

The bed is heavily ribbed and has rectangular guides which afford a maximum wearing surface for the cutter slide. The cutter slide has long and narrow guides provided with a handy tapered gib adjustment; three gibs are used, and as they are all located on the outside, it is an easy matter to make inspections or adjustments. The cutter spindle has both a straight and a taper bearing running in a solid bronze box. The customary bushings are eliminated, thus permitting a much larger cutter spindle to be used. The end of the spindle is No. 13 B. & S. taper and is provided with a squared recess to drive the arbor.

The positive tripping mechanism which is shown in detail in Fig. 3 is controlled by two independent shafts which are operated from the working side of the machine. These shafts are revolved by a crank-wrench; they are easily set and means are provided for holding them positively in place after the desired setting has been obtained. Brass plates are placed directly over the shafts to indicate the direction of movement of the trips. The work saddle is gibbed to the housing in such a way that loosening the clamp bolts to adjust the work does not cause the work-spindle to drop out of alignment. The saddle can be raised or lowered by either hand

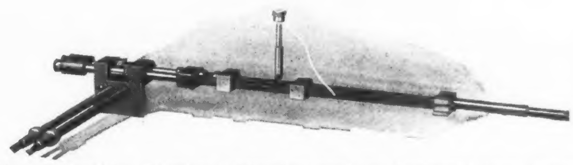


Fig. 3. Positive Tripping Mechanism used on Cincinnati Gear Cutter

or power and the elevating screw for the work saddle rests on ball bearings, a micrometer dial reading to 0.001 inch being provided to enable accurate settings to be made. The work-spindle is tapered to provide for taking up wear and runs in bronze bushings. The arbor end of the spindle is provided with a special tapered hole 3.81 inches in diameter at the larger end and tapering ½ inch to the foot. The nose of the spindle is keyseated and tapped for screws, thus providing for securing a faceplate or special chucking devices to the spindle.

The feed-screw is of large diameter and runs in a bronze nut which is shielded from dirt and chips. The feeds for the cutter slide are obtained by a quick change mechanism giving twelve changes from 1 to 13 inches per minute, the changes being in geometrical progression. The return of the cutter slide is always constant. By transposing gears, the cutter spindle can be given six changes of speed ranging from 12 to 68 revolutions per minute, these changes also being in geometrical progression.

The outer work arbor support is one feature of the design of this machine. This support is made extremely heavy and is counterbalanced. A rack and pinion afford a convenient means for moving the support when chucking and taking off work. The faceplate carries two dogs and two jacks that are adjustable around the circular T-slots and radially along slots in the dogs and jacks. A safety stop of simple construction prevents the cutter slide from feeding forward until the indexing is complete, and this stop also prevents the cutter slide from being in-

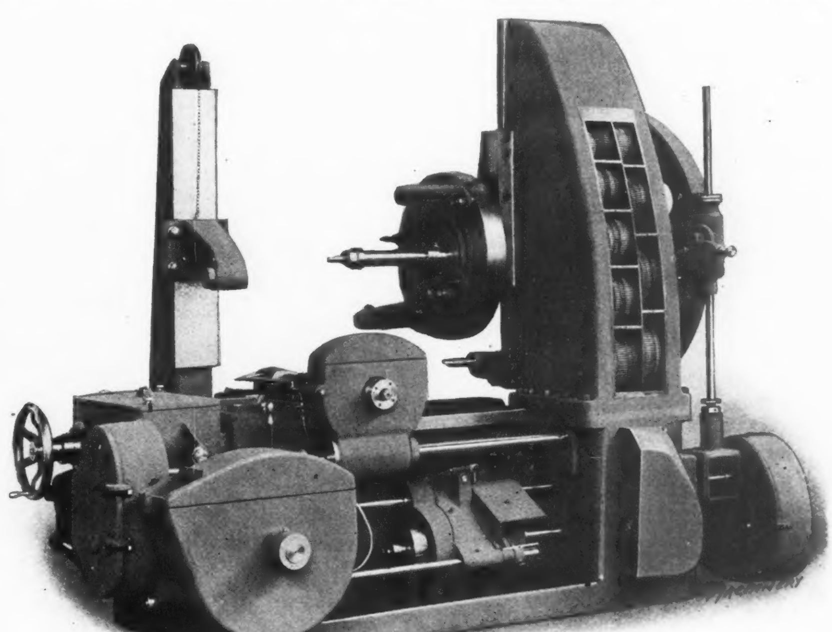
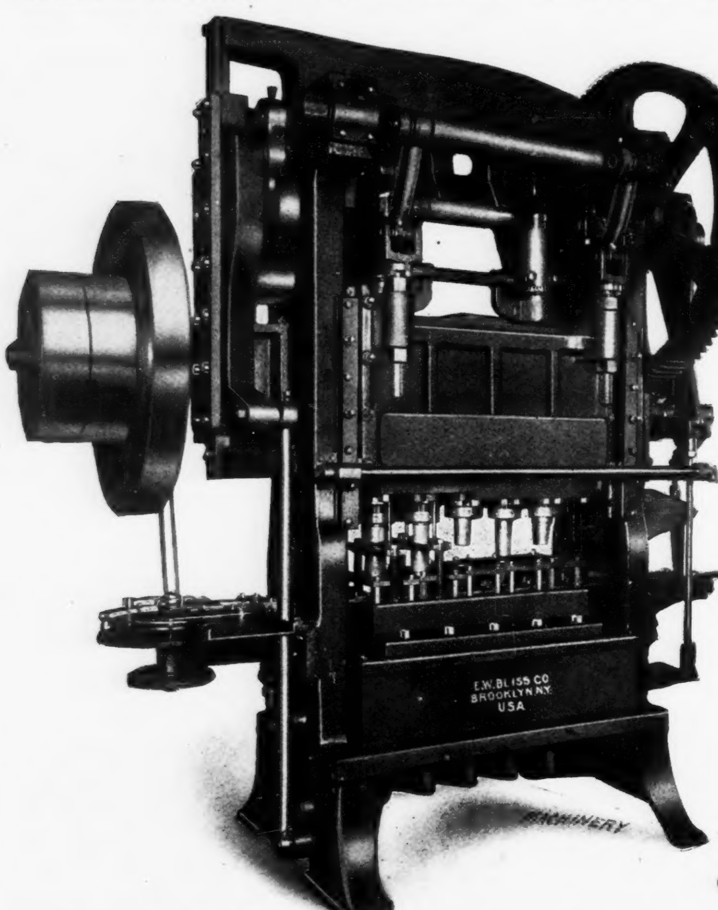


Fig. 2. Rear View of Automatic Spur Gear Cutter

dexed by hand while the cutter is going forward. All of the shafts in the machine are shouldered and can be removed from their bearings without removing the keys and bushings

or threading keys through their slots. The machine indexes all numbers from 4 to 100 and from 100 to 450 with the exception of prime numbers and their multiples. The index wheel is 53 inches in diameter. All of the gearing in the machine is completely enclosed and the main driving gears run in an oil bath. The net weight of the machine is 19,500 pounds.



Bliss Press with Dial and Lateral Feeds for Successive Drawing Operations

BLISS PRESS WITH DIAL AND AUTOMATIC CROSS FEED

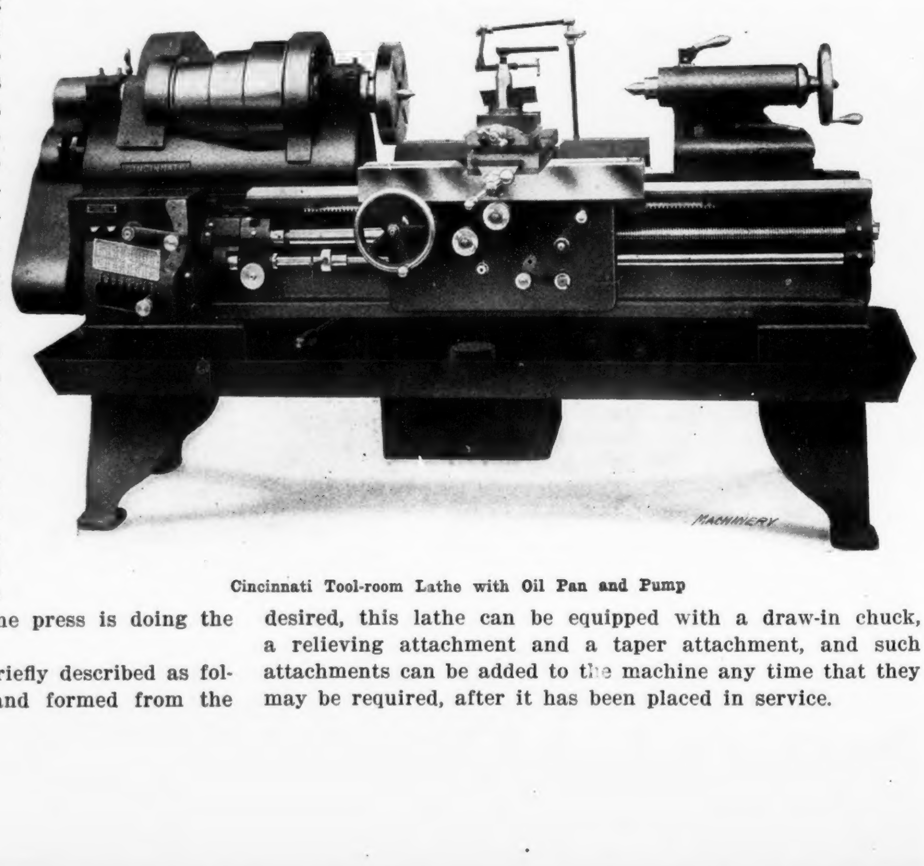
The development which has been made in methods of working sheet metal has led to the design of numerous automatic feed mechanisms for power presses as a means of increasing production. The accompanying illustration shows an automatic feed press which has recently been added to the line of the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine is adapted for the rapid production of deep drawn, seamless shells, such as lamp and lantern bodies, oil-can bodies, drinking cups and similar articles, which require a series of drawing operations. This press is equipped with a friction dial feed and lateral carrying feed, and has five slides, each of which are independently adjustable. Five operations are performed at each revolution of the crankshaft, from which it will be evident that the output is increased and production costs correspondingly reduced over any method of doing the work in a single-slide, double-action press. Furthermore, handling of the work between operations is eliminated and a considerable saving of space is made possible, due to the fact that one press is doing the work of five single presses.

The operation of the press may be briefly described as follows: Shells which have been cut and formed from the sheet are placed on the revolving disk of the friction dial feed which carries them up and against an automatic stop gage that allows one shell to pass at each revolution of the crankshaft. On passing from the friction dial feed, the shells are gripped by the lateral feed which automatically carries them to the successive dies in which the drawing operations are performed, and finally discharges the finished piece through a chute at the right-hand end of the press. The press operates at thirty-five strokes per minute, which means 100,000 operations in a ten-hour working day.

It will be evident from the preceding description that this method of feeding work to the press does away with the danger which the operator runs in feeding work by hand, as it is merely necessary to place the shells on the revolving dial which carries them into the machine. The lateral feed has two motions—an opening and closing, and a backward and forward motion. This feed mechanism is operated by cams and links from both ends of the machine, the design affording a perfectly parallel feed motion. The bottom knock-out is cam-actuated and driven from the crankshaft through links and levers, the design being such that its travel for each slide may be different according to the depth of the drawing operation which is performed by the slide. The press is equipped with an automatic friction clutch which places its movements under practically instant control of the operator. With this type of press, the number of operations which may be performed simultaneously is only limited by the number that may be performed without annealing the work, so that wider presses having a greater number of slides could easily be used. The approximate weight of the machine with five slides, shown in the illustration, is 25,000 pounds.

CINCINNATI TOOL-ROOM LATHE WITH OIL PAN AND PUMP

The tool-room lathe equipped with an oil pan and pump which is shown in the accompanying illustration has been recently added to the line of the Cincinnati Lathe & Tool Co., Oakley, Cincinnati, Ohio. As will be seen from the halftone, the head is driven by a wide three-step cone and double back-gears, and the machine is especially adapted for heavy duty. The quill on the double back-gears is made of steel and both ends are bronze bushed. A sleeve is provided on this quill for shifting the gears from the front of the machine. When desired, this lathe can be equipped with a draw-in chuck, a relieving attachment and a taper attachment, and such attachments can be added to the machine any time that they may be required, after it has been placed in service.



Cincinnati Tool-room Lathe with Oil Pan and Pump

NEWTON 40-INCH COLD SAW

The illustrations show a 40-inch cold saw which has been added to the line of the Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine has been designed especially

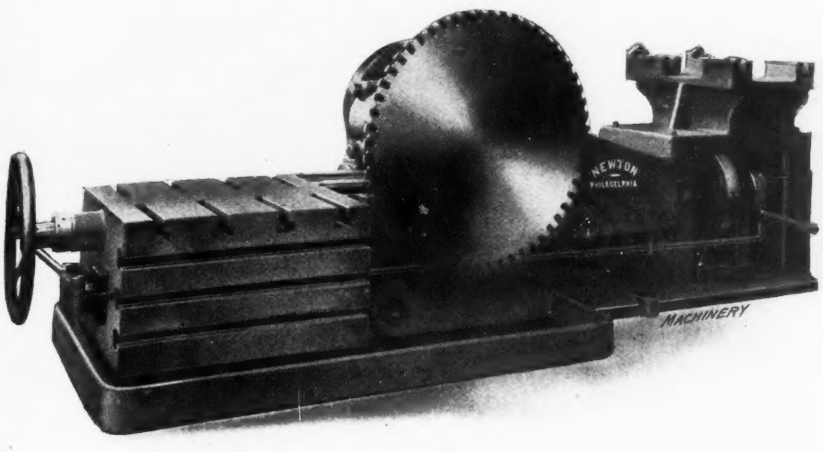


Fig. 1. Newton 40-inch Cold Saw

for use in steel foundries and for sawing operations on chilled rolls. In order to adapt it for severe service of this character, the spindle, pinion shaft and all driving gears are of exceptionally large diameter. All gears are made of alloy steel with the exception of the driving worm-wheel, which is machined from a solid bronze casting. The driving worm is of hardened steel, fitted with roller thrust bearings, and the driving spline shaft is fitted with rotating auxiliary bearings, to protect the stationary bushings from the key splines and also to prevent the escape of oil. All of the bearings are bronze bushed. The spindle revolves in cap bearings and is supported at both ends.

Vertical and horizontal adjustments are made by taper shoes, and the saddle is equipped with a narrow guide bearing on the base to control its alignment and also to save power by preventing the saddle from binding on the base. In addition, the base has three shears to give an ample bearing for the saddle. The gear feed-box which is used rovides six changes without requiring the removal of gears. A quick return motion is also provided which may be tripped at any predetermined point and at the end of the stroke in both directions. The entire base of the machine, including the work-table, the ways for the saddle and the extension on which the feed mechanism and motor pads are mounted, is one solid casting. This entire casting has an oil pan cast integral with it which runs all around the base. The top surface of the main work-table has T-slots running at right angles to the direction of travel, the size of the work-table being 32 by 37 inches. The vertical face of the main work-table is fitted with three T-slots in the faced portion, which is 18½ by 37 inches in size. An auxiliary table, mounted on parallels, has a top surface 36 inches square and a vertical clamping surface 24 inches deep. The use of this table is particularly convenient in handling some classes of work for which a machine of this type is used.

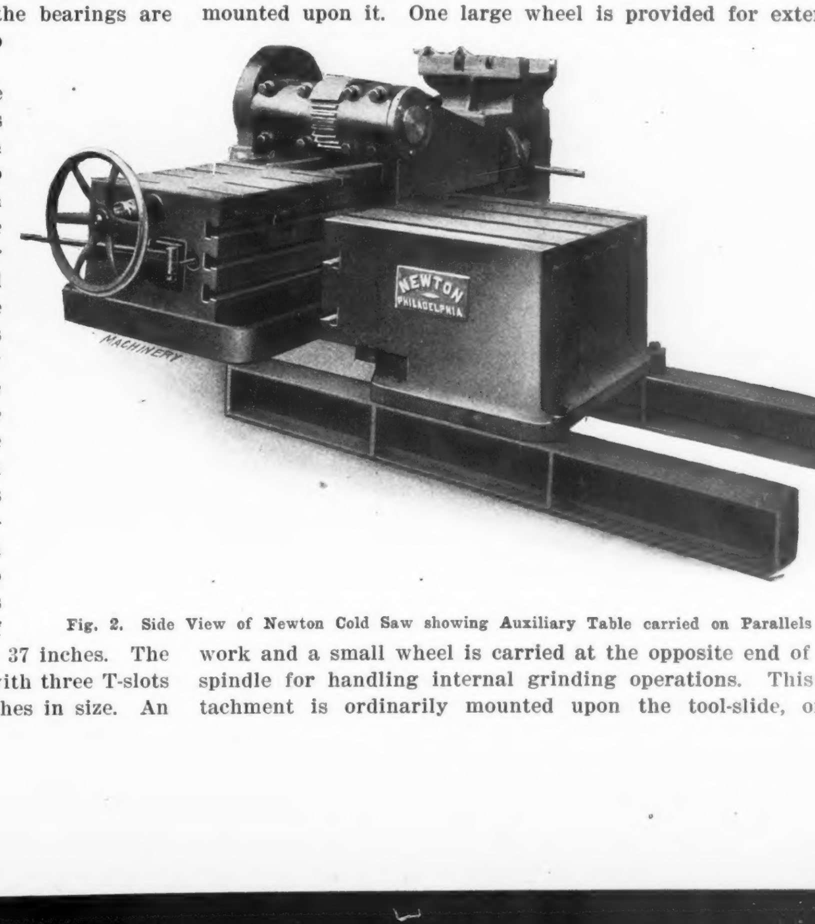


Fig. 2. Side View of Newton Cold Saw showing Auxiliary Table carried on Parallels

Particular care has been taken to obviate the possibility of "chatter" in this machine, which experience has shown to be more destructive in its effect upon saw teeth than any other defect in a cold saw. With this object in view, the feed-screw has been provided with a bearing at each end to insure having it operate in tension. The feed and fast power return are controlled from either the front or rear of the machine, which is one of the convenient features of the method of operation. A 23-horsepower motor running at 310 to 930 revolutions per minute is used for driving the machine. This motor is mounted on the bracket provided for this purpose, the motor having been removed from the machine at the time the photographs were taken. The motor transmits power to a driving pulley 30 inches in diameter by 10½ inches face.

FORBES & MYERS LATHE GRINDING ATTACHMENT

The grinding attachment for lathes illustrated herewith is a recent product of Forbes & Myers, 172 Union St., Worcester, Mass. It will be seen from the illustrations that this attachment is electrically driven, the armature spindle being extended at either end to enable the grinding wheels to be mounted upon it. One large wheel is provided for external work and a small wheel is carried at the opposite end of the spindle for handling internal grinding operations. This attachment is ordinarily mounted upon the tool-slide, or a

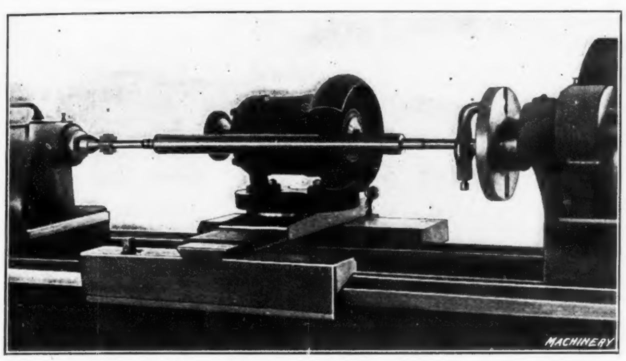


Fig. 1. Forbes & Myers Grinding Attachment in use on External Work

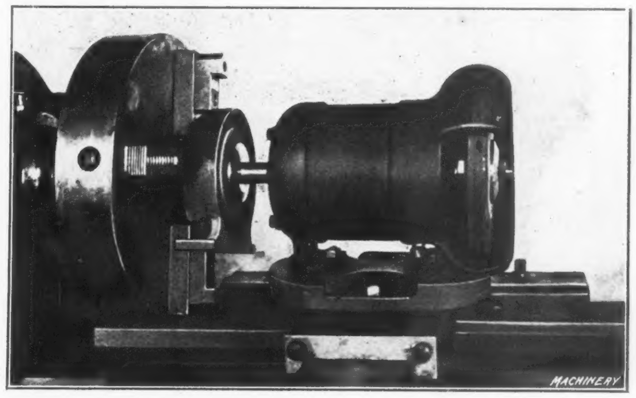


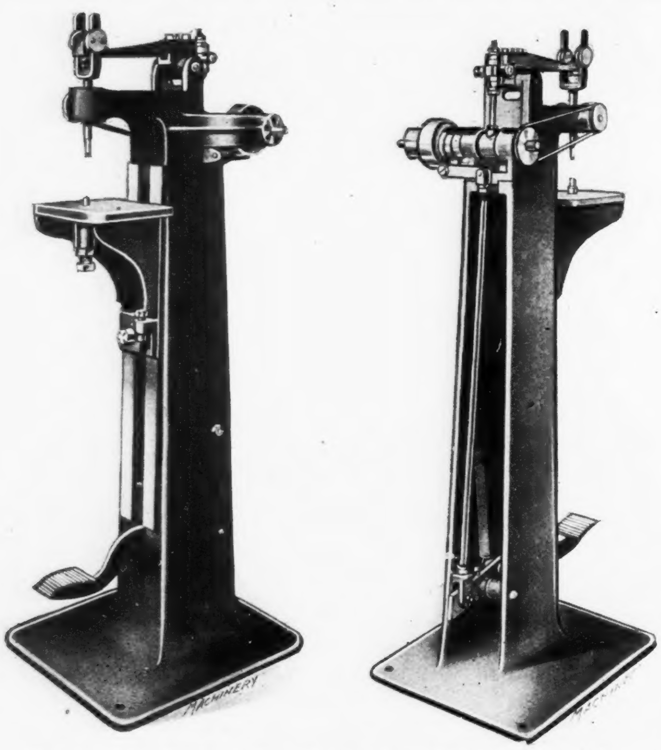
Fig. 2. Grinding Attachment working on an Internal Grinding Operation

raising block made to fit special lathes may be used when such a method is more desirable.

The electric motor will give ¾ horsepower when used intermittently, as in the case of most grinding operations on lathe work. The motor is of the squirrel cage, induction type, a convenient switch being provided for starting and stopping the motor. The design of the motor has been worked out so that it is thoroughly protected against dust and grit by means of a cover which fits tightly around the shaft. The motor has no commutator, brushes, clutches or other parts which are likely to give trouble. The spindle is carried in ball bearings which insure efficient operation. The regular wheel furnished for external work is 7 inches in diameter by 1 inch face, while the internal grinding wheel is 3 inches in diameter by ½ inch face. The grain and grade of these wheels is that which experience has shown to be best suited for general classes of work, but wheels of any make or style will be furnished when so specified.

GRANT ROTARY VIBRATING RIVETER

The No. 2 rotary vibrating riveter, front and rear views of which are illustrated in Figs. 1 and 2, is a product of the Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. This machine has a capacity for rivets up to ¼ inch



Figs. 1 and 2. Front and Rear Views of Grant Rotary Vibrating Riveter

in diameter and has been developed for operating in close corners where it is impossible to reach the work with the regular rotating roll riveting machines of this company's manufacture. The spindle of the machine is operated through an eccentric mechanism, which is clearly shown in Fig. 2, motion being transmitted to the riveting spindle by means of a hickory helve. A rubber ball is interposed between the helve and the spindle to absorb vibration. In addition to its vibrating motion, the spindle is positively rotated by means of a worm and wheel. The worm carries a grooved pulley at one end which is driven by a round belt running over a similar pulley on the driving shaft. These pulleys are of slightly different diameters, and it is often found desirable to change them in order to vary the rotating speed of the riveting spindle.

The machine is driven by a one-inch belt which transmits power from a 10-inch pulley on the countershaft to a friction driven pulley on the machine. The pulley on the machine runs free and is engaged by a friction clutch when it is desired to operate the machine. The clutch is controlled by a foot treadle, and when this treadle is released, the pulley is once more allowed to run free, while a brake is automatically applied to the driving shaft to stop the machine almost instantly. There is also a friction stopping device connected with the machine which causes the spindle to stop at its highest point, thus permitting the work to be easily inserted or removed.

SUSPENSION BALL BEARING

Fig. 1 shows an end and sectional view of the type of ball bearing which is manufactured by the Suspension Roller Bearing Co., Sandusky, Ohio, and Fig. 2 illustrates one of these bearings mounted in a lineshaft hanger. The design of this bearing differs considerably from the form of construction which is followed by most manufacturers. Instead

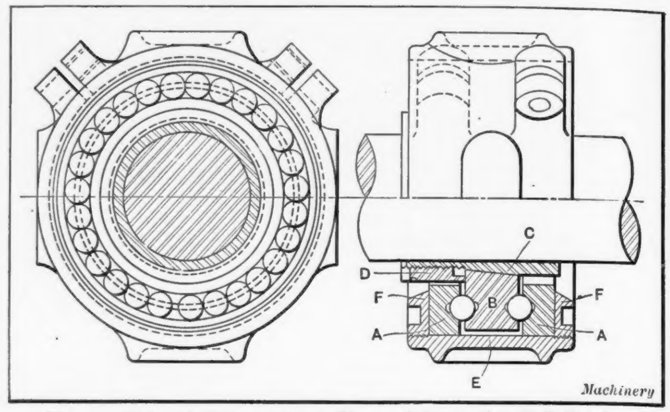


Fig. 1. End and Cross-sectional Views of Suspension Ball Bearing

of having the balls encircled by an outer race with a companion race on the inside, it will be seen that the races of this bearing consist of parallel plates *A* and *B* between which the balls are carried in race grooves. The construction is clearly illustrated in Fig. 1, where it will be seen that a collet *C* surrounds the shaft and holds the inner race on its tapered section. The inner race *B* is held in position on the tapered collet *C* by means of the binding nut *D*. The bearing is assembled in a case *E* in which the parts are held in place by means of the adjusting nuts *F*.

The construction of this bearing causes the pressure to be applied to the balls in such a way that they rotate on an axis inclined at an angle of about 45 degrees to the horizontal. In this way, the effect of radial or thrust loads upon the action of the balls is practically the same so that the

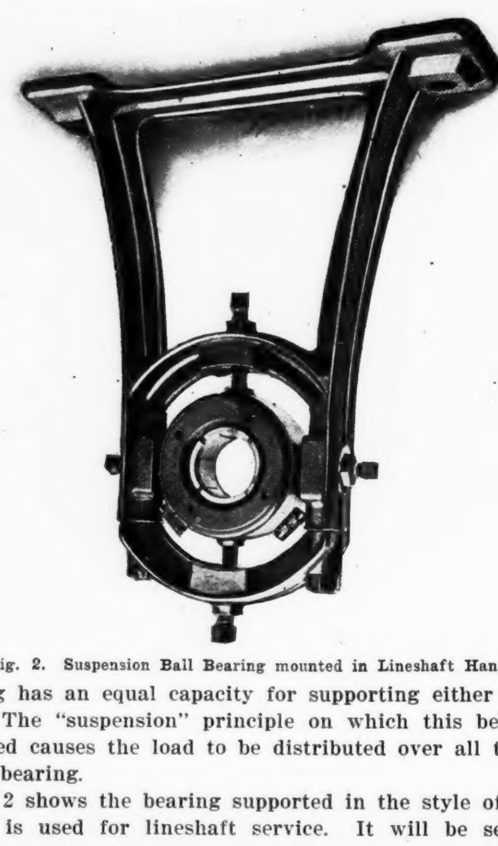


Fig. 2. Suspension Ball Bearing mounted in Lineshaft Hanger

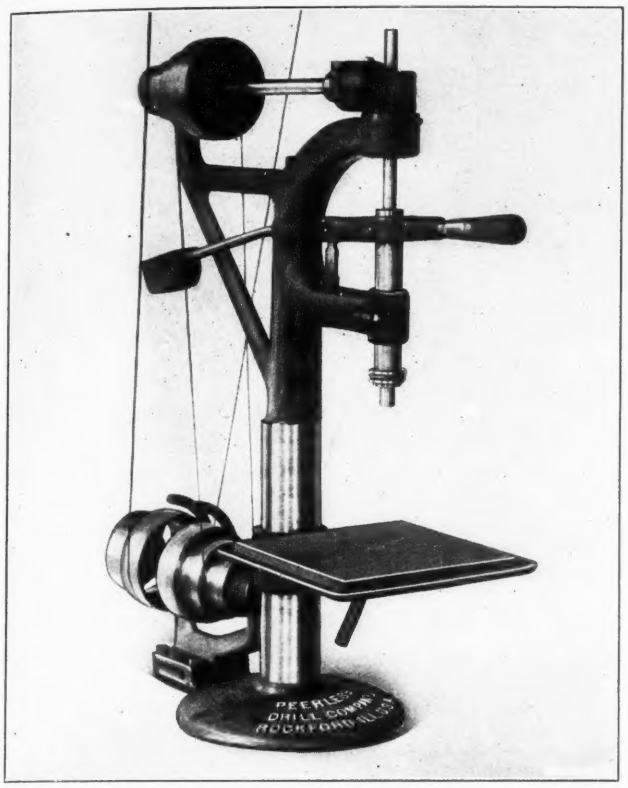
bearing has an equal capacity for supporting either kind of load. The "suspension" principle on which this bearing is designed causes the load to be distributed over all the balls in the bearing.

Fig. 2 shows the bearing supported in the style of hanger which is used for lineshaft service. It will be seen that

this hanger is provided with the usual style of adjusting screws for regulating the alignment of the shaft. The construction of the bearing case is such that it is dirt- and dust-proof and the bearing runs without requiring frequent lubrication. Enough oil is kept in the bearing case to protect the parts from rust, the oil playing little, if any, direct part in the mechanical action of the bearing.

PEERLESS TWELVE-INCH BENCH DRILL

The 12-inch ball bearing bench drill shown in this connection is a product of the Peerless Drill Co., Rockford, Ill.



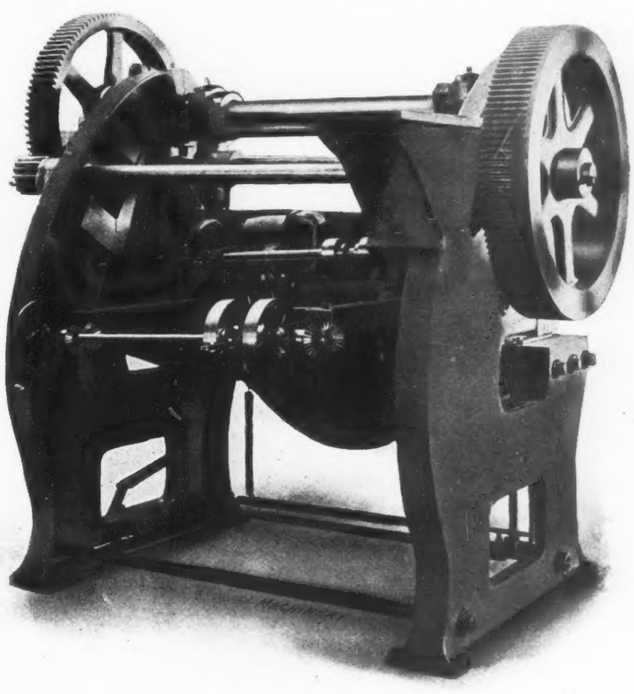
Peerless 12-inch Ball Bearing Bench Drill showing Use of Twine in Place of Driving Belts

It will be seen that this machine is equipped for hand feed, a small steel link being used between the feed lever and the frame of the machine to afford the required vertical movement for the coupling on the drill spindle bushing. The arrangement will be readily understood from the illustration, where it will be seen that the counterweight used on this machine provides for the return of the spindle when the feed lever is released. Spiral gears are used to transmit power from the pulley shaft to the drill spindle, these gears being completely enclosed. The table is of unusually large size for a machine of this type, thus affording plenty of room for any jig that may be used. An oil channel is provided which runs all the way around the table. The machine shown in the illustration is equipped with ball bearings and machines of this type are also built with plain bearings instead of the ball bearings, the style of plain bearings used being made adjustable and self-oiling.

One of these ball bearing drills was recently subjected to rather an unusual test in the manufacturers' shops. Light twine was used in place of the usual driving belts, and with this arrangement a No. 31 drill was driven through a piece of cast iron one inch in thickness in forty-five seconds. During this test the spindle was driven at 1000 revolutions per minute. The ability of the machine to do work when driven in this way shows the high degree of sensitiveness which has been attained by the manufacturer in the bearing construction.

NIAGARA SQUARING SHEAR

The power squaring shear illustrated herewith is a recent product of the Niagara Machine & Tool Works, Buffalo, N. Y. The important feature of this machine consists of a device for adjusting the back gage by means of an electric motor.



Niagara Squaring Shear with Motor-driven Back Gage Attachment

The motor used for this purpose is mounted on the back web of the bar that carries the upper knife and drives an intermediate shaft which transmits power to the bevel gear shaft by means of straight and crossed belts. The motion of the bevel gears is transmitted to the back gage by means of two feed-screws, and a reversing clutch controlled by a hand lever is provided on the pulley shaft to provide for moving the back gage to the required position. In this way the

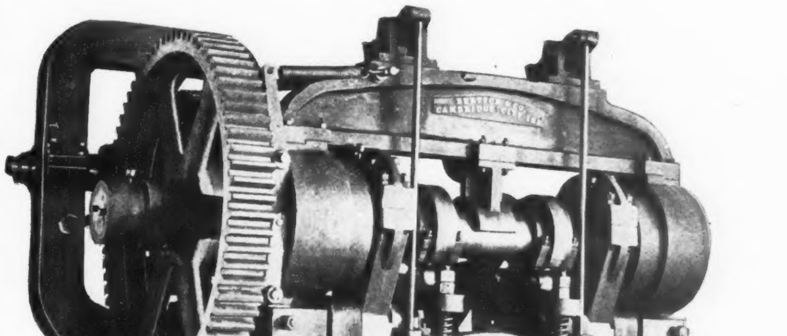


Fig. 1. Left-hand Side of Bertsch Five foot Gate Shear

width of the stock to be cut off by the machine can easily be controlled. The back gage brackets are fastened to the

cutter bar and there is a graduated scale mounted on one of the arms to facilitate setting the gage. This attachment is of particular benefit where it is necessary to adjust the back gage frequently in order to cut strips of different widths.

BERTSCH FIVE-FOOT GATE SHEAR

Bertsch & Co., Cambridge City, Ind., have recently added to their line the five-foot gate shear shown in Figs. 1 and 2. This machine is adapted for shearing operations on plates up to 1¼ inch in thickness and is built along massive lines to adapt it for heavy work of this character. The shafts are made of forged steel and run in liberal sized bearings. All of the gears in this shear are machine cut. The clutch has steel jaws and a cast-steel switch ring which acts against a hardened tool-steel roller on the plunger. The action of the clutch is automatic and positive. In addition to the table, the machine is built with two heavy cross-tie members bolted to the end housings, one of these cross-ties being at the top and the other at the rear of the crosshead. This design adds greatly to the rigidity of the machine.

The form of hold-down used on this machine does not obstruct the shearing line in any way. The hold-down feet or gags can be easily and quickly disengaged, either for the purpose of removing the top blade or for operating the shear without a hold-down. The removal of the gags does not require the entire hold-down frame and its connections to be removed. It will be seen from the illustrations that the machine is equipped for direct motor drive. A five-foot machine is shown in the illustrations, but machines of this type are built in lengths up to 12 feet and equipped with motor, belt or hydraulic drive.

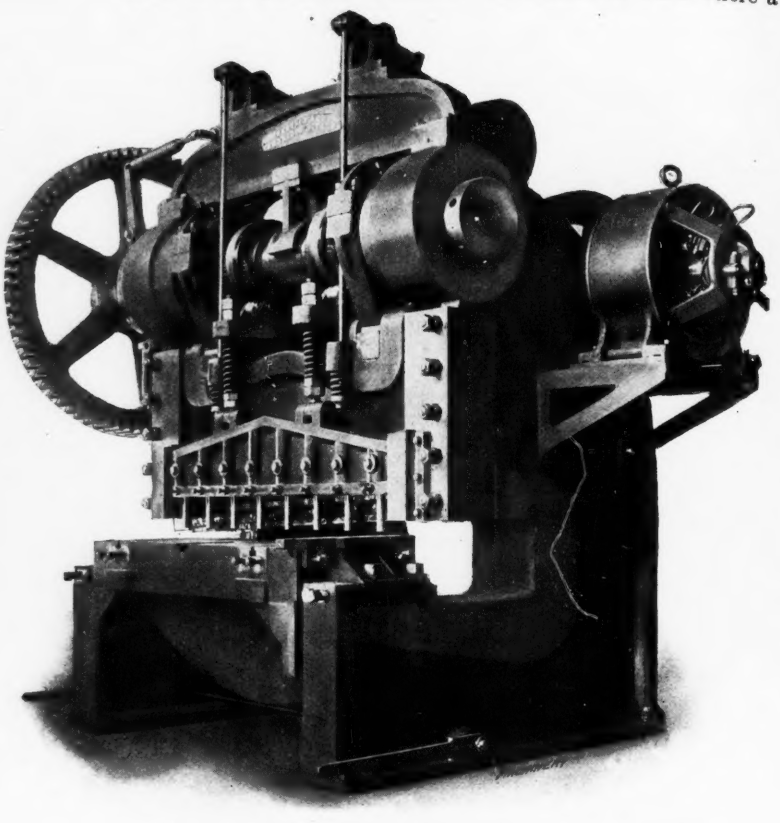


Fig. 2. Right-hand Side of Bertsch Shear showing Application of Motor Drive

NEW MACHINERY AND TOOLS NOTES

Drilling Machine: Canedy-Otto Mfg. Co., Chicago Heights, Ill. A 20-inch drilling machine, the spindle of which is 1¾ inch in diameter and provided with a No. 3 Morse taper hole. Either hand or power feed may be used as desired.

Vertical Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A milling machine especially adapted for milling railway-motor spiders; this machine may also be used to advantage for machining keyseats. In the latter operation only end mills are used.

Improvement on Cowan Transveyor: Cowan Truck Co., Holyoke, Mass. A release check for the Cowan transveyor which enables the operator to release the load independently of the handle. This check lowers the heaviest loads for which the truck is adapted without shock.

Steel Pipe Threading Die: Pipe Machinery Co., Cleveland, Ohio. A [illegible]e threading die which will thread open-hearth steel, Bessemer steel or wrought-iron pipe with equally good results. The die is of the expanding type, the chasers being opened and closed by means of a thread movement in the die body.

Pneumatic Pyrometer: Uehling Instrument Co., Passaic, N. J. An improved type of pneumatic pyrometer adapted for furnishing a continuous autographic record. This instrument is particularly designed for use in connection with blast furnaces and can be provided in the single, double, triple or quadruple form.

Flow Meter: General Electric Co., Schenectady, N. Y. An improved type of meter adapted for measuring flow of steam, water, air and other fluids through pipes. This meter is designed to meet the demand for a strong and serviceable instrument which can be used not only as a testing instrument, but as a stationary meter for the continuous measurement of the flow of either gases, liquids or vapors delivered through the pipes in an industrial plant.

Electric Tachometer: Electric Tachometer Co., Broad and Spring Garden Sts., Philadelphia, Pa. This tachometer was originally designed for use on motor boats, aeroplanes, etc., but has been adapted for use on machine tools. It consists of a small direct-current magneto-generator and an indicating volt meter. The instrument operates on the well-known principle that when a system of coils is rotated within a permanent field, an electric voltage is generated which is proportional to the speed of rotation.

Hydraulic Forcing Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A hydraulic press capable of exerting pressures up to 1000 tons, which has been designed for general forcing work in the machine shop. The largest diameter which can ordinarily be handled between the strain rods of the press is 48 inches. On classes of work where a greater space is required, but where the pressure need not be excessively high, the press may be adapted for handling work up to 84 inches in diameter.

Cutter Grinder: Cincinnati Milling Machine Co., Cincinnati, Ohio. A machine which retains the features of this company's established type of cutter grinder, but in which the design has been modified to make the present type more rigid and to extend its capacity for larger sizes of cutters. The centers swing 10 inches in diameter and have a capacity for work up to 17 inches in length. The table has a longitudinal movement of 16 inches, a vertical movement of 7½ inches and a cross movement of 9½ inches.

Manufacturing Milling Machine: Cincinnati Milling Machine Co., Cincinnati, Ohio. A milling machine designed to handle the class of work for which the Lincoln type of millers has been almost exclusively used. The design of the machine has been worked out along the generally established lines followed in the construction of Lincoln millers, but has been improved in many details. It is made in three different styles which comprise a regular machine having one head and outboard support for the arbor; a duplex miller; and a machine in which the bed has been shortened and the tailstock left off, thus adapting it for face milling operations.

Double-crank Toggle Drawing Press: Ferracute Machine Co., Bridgeton, N. J. The ram is driven by toggles, actuated by a cam groove in a large gear at the left-hand side of the machine, and a yoke connected with the toggle shafts. The arrangement is such that the ram reaches its lowest position and remains stationary while the plunger completes the last half of its downward stroke and makes the first half of the return stroke, thus giving a dwell of 180 degrees to the blankholders. The press is adapted for producing seamless work as deep as 15 inches; it exerts a pressure up to 500 tons and weighs about 135,000 pounds. Two larger and four smaller presses of the same type are being manufactured by the Ferracute Machine Co.

* * *

Moreau, a Frenchman, has succeeded in developing an aeroplane in which the difficult problem of automatic stability is practically solved. In a recent flight made under military auspices, the aeroplane remained in the air for 35 minutes during which time the pilot did not have to touch any of the steering parts; in fact, Moreau stated before ascending that he would make the entire flight with folded arms, and this condition he fulfilled.

THE EFFICIENCY ENGINEER AND THE CONTINGENT FEE

John Archibald was an efficiency engineer—at least that is what he called himself. There is no question but that he was very efficient in making his presence known whenever he was around. He made a business of placing old-fashioned plants upon a basis where they could double their dividends—at least that is what he said he did, and on the strength of what he said about himself, he was called into consultation by the owners of the Smith & Brown Co., which has done a profitable business for the last twenty-five years. The president thought that there might be something in this new efficiency hobby after all, and it might be worth while investigating.

Thus it came about that one sunny morning Mr. Archibald appeared at the Smith & Brown plant and began taking notes of the very inefficient methods that they were using; and he was quite frank about letting them know that he could see opportunities for improvement right and left. He studied the conditions for a week or so and then he made his report which was to the effect that he saw chances for decreasing costs to the extent of $40,000 or $45,000 a year. He also reported that this improvement could be made if he were hired as efficiency expert and given two assistants of ordinary training and intelligence. (Mr. Archibald's training and intelligence, it is understood by this time of course, was above the average.) He further intimated that his services would be worth $5000 a year, and as his assistants could be hired for very little money, a saving of at least $40,000 a year could be accomplished with an almost negligible initial expense. This report ought to have pleased the Smith & Brown Co., and it undoubtedly did, but the prospects of the coming prosperity somehow burst so suddenly upon the owners that they were unable to decide right away as to what to do. They agreed however, to write to Mr. Archibald within a few days stating their intentions. In a few days Mr. Archibald received the following letter from Mr. J. P. Smith, the president of the Smith & Brown Co.:

MR. JOHN ARCHIBALD,
24 Blank St., New York City.

Dear Sir: We have carefully considered your report regarding the possibilities for increased efficiency in our plant. We think, however, that the compensation which you expect for your services is entirely too modest and is not commensurate with the great saving that your knowledge and ability would accomplish in our plant. We therefore propose that instead of paying you a fixed salary of $5000 a year, as stated in your memorandum, we share with you the entire resulting savings of the first year, after the system which you will install has been put into operation, you receiving one-half of this saving. We think that this arrangement will be entirely agreeable to you and expect to hear from you at an early date. Yours very truly,

J. P. SMITH, Pres.

It has always seemed very peculiar to Mr. Smith that he never heard from Mr. Archibald in answer to this proposition. Of course he has a high regard for Mr. Archibald's honesty and personality, seeing that he refused to accept $20,000 for his services when he, himself, had placed a value of only $5000 a year on them. But Mr. Smith's partner, Mr. Brown, who is less of an idealist, suspects that if all efficiency engineers (so-called) were to be paid on the basis proposed by Mr. Smith, there would not be one-half as many of Mr. Archibald's type running around loose as there are—but then, of course, Mr. Brown never believed in this efficiency business anyway, so his opinion is naturally prejudiced. E. O.

* * *

A quick and satisfactory method of coloring drawings requires the use of ordinary wax crayons and gasoline only. Crayon of the color desired is applied and then rubbed with a piece of cloth wet with gasoline until the color is even and extended to the limits desired. If it overruns the lines it can be erased with a pencil eraser. Some colors, particularly the yellows, purples, greens and light blues, produce much better results than others. It is believed that the gasoline dissolves the wax from the crayon, leaving the pigment as an impalpable powder, which when rubbed over the paper colors it uniformly. The method is applicable with equal success to eggshell and smooth drawing papers and to white prints on both paper and cloth.—*Engineering and Mining Journal.*

A BULLDOZER DIE

A very simple but efficient die designed and built by Williams, White & Co. of Moline, Ill., is shown in the illustration attached to one of this company's bulldozers. This die is used to bend stirrups for locomotive springs in one heat. Three strokes are required. The ends of the bar are scarfed and bent around before being placed in the bulldozer die. The first operation is bending the bar to a U shape. This is done in the right-hand part of the die. Next one leg

Bulldozer equipped with Die for forming Locomotive Spring Stirrups

of the U is bent at right angles across the top, in the left-hand part of the die; then a piece *A* is removed from the traveling die equal to the thickness of the stock. The incompleted stirrup is now turned over on the same part of the die and the other leg is bent across the top, thus completing the stirrup as shown at *B*. The stock is spring steel, 5/8 inch by 2 inches, and the stirrup when completed is about 6 1/4 inches by 11 inches over all. The machine runs at ten strokes per minute and three strokes are caught in succession for bending a stirrup.

* * *

STEEL FOR PERMANENT MAGNETS

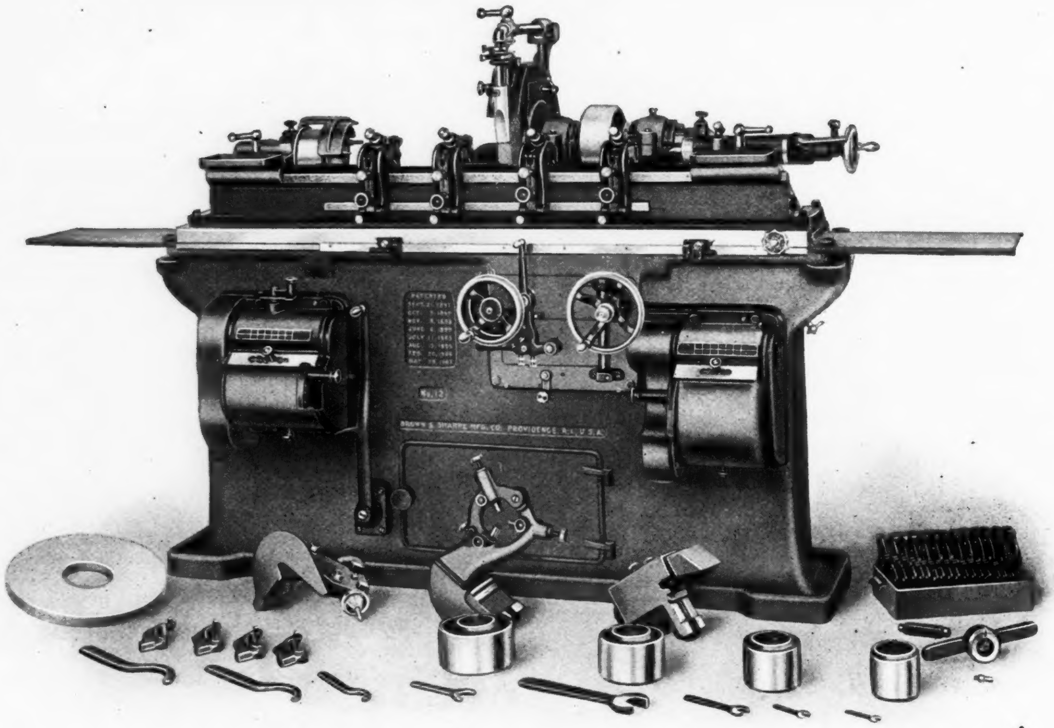
Steel containing 5 1/2 per cent tungsten makes excellent permanent magnets. The steel should be heated above the recalescence point and when quenched should show a fine-grained fracture. After magnetizing a magnet should be "aged" by prolonged heating in boiling water or steam. A short bar magnet tends to lose its magnetism quickly; the coefficient of demagnetization for a bar magnet twenty-five diameters in length is 0.05 while that of a magnet five diameters long is 0.5, or ten times as great. A bar magnet five hundred diameters long is supposed to be permanent. The magnetic force of the best magnets is considered by Prof. S. P. Thompson to be only 60 to 80 per cent of what may be eventually attained.

* * *

MOVING PICTURE TARGETS

New zest has been given to shooting in rifle galleries by the introduction of moving pictures as targets. The apparatus projects animals, birds, vehicles, etc., in rapid motion on the screen, and by ingenious means the marksman is shown how close his shots come to the object aimed at. At least two systems have been developed for registering hits on moving pictures, description of one of which, taken from the *Saturday Evening Post*, is substantially as follows: For the success of the apparatus it is essential that means be provided for stopping the film when a shot is fired. Without such control it would be impossible to determine accurately where the bullet struck and consequently the principal element of rifle-range pleasure would be lost. The sound of the shot stops the film automatically. A delicate microphone that responds to any sound is violently vibrated by the sound of the shot and the vibration causes it to throw on an electric current which puts brakes on the moving picture machine, or in other words to press a button and stop the machine. The stop is almost

AN IMPROVED DESIGN OF



All Work Speeds and Feeds are Instantly Available from Operating Position Without Shifting Belts

An entirely new method of obtaining feed and speed changes is now employed on the No. 12 Plain Grinding Machine shown above. Two quick change gear cases are located on the front of the bed; the right hand one controls the work speeds and the left hand, the table feeds. This gives full control of the work from the front of the machine.

BROWN & SHARPE MFG. CO.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa. 626-30 Washington Blvd., Chicago, Ill. 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa.; Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

PLAIN GRINDING MACHINE

NOTE how quickly and easily the operator can make feed and speed changes without leaving his position, or without shifting belts. To obtain any one of the available speeds or feeds he simply shifts an index slide and moves a lever as far as it will go. Consider what a saving in time this means on manufacturing work. Duplicate pieces having several different diameters can be ground more rapidly, since the correct speed and feed for each diameter can be instantly obtained. When changing from one job to another the speed and feed is also quickly and easily adjusted. Any change of feed can be made without stopping the wheel or table. The operator is also able by the simple movement of a lever to change from a fast feed for roughing to a slow feed for finishing, without disturbing the setting of the feed levers. All changes of wheel speed are made on the machine, by means of split pulleys of various diameters which are readily changed without removing the belt.

RESULT OF THE NEW DESIGN
EASIER OPERATION—INCREASED PRODUCTION

PROVIDENCE, R. I., U. S. A.

CANADIAN AGENTS: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfurt a/M. Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

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instantaneous. Often the stop comes on the next picture succeeding the one fired at, but as the pictures succeed one another at the rate of sixteen a second, the difference between them is slight and the following picture shows closely enough the location of the illuminated bullet hole in relation to the object fired at.

The construction of the screen is ingenious. It is made of three thicknesses of heavy paper. One thickness of paper unwinds from a roll of paper at the top of the screen and winds up on a roll at the bottom and these rolls are given a slight turn occasionally by an attendant. The other two thicknesses slowly but continuously unwind from rolls on one side and wind up on rolls on the other side, but they travel in opposite directions. A few seconds after the shot has penetrated the sheets, the movements have automatically closed the hole. Back of the screen is an electric light so placed as to be out of the range of shots and still shine through the hole in the sheet and thus disclose its location relative to the arrested picture on the screen.

The chief difficulty met with in the operation of these machines has been to prevent the film from catching fire when stopped. A fan is provided to blow the hot air away from the film when it stops and thus prevent the temperature rising to the igniting point.

* * *

PERSONALS

E. F. Lake, who conducted a metallurgical engineering business in Bayonne, N. J., has moved the same to 1453 Waterloo St., Detroit, Mich.

J. E. MacArthur of the Pierce Arrow Motor Car Co., Buffalo, N. Y., has resigned his position to become superintendent of the Keystone Mfg. Co. of Buffalo.

William H. MacGregor, president and general manager of the National Twist Drill & Tool Co., Detroit, Mich., recently returned from a two months' business and pleasure trip in Europe.

W. G. Dunkley of Salford, Manchester, England, an occasional contributor to MACHINERY, has received the Bachelor of Science degree in engineering at London University as an external student.

A. M. Powell, president of the Powell Machine Co., Fitchburg, Mass., returned from a European trip on the *Laconia* August 19. Mr. Powell made the trip abroad in the interest of the Powell "Hy-Speed-Cut" planer.

John Goetz has been appointed superintendent of the Kempsmith Mfg. Co., Milwaukee, Wis., manufacturer of milling machines. Mr. Goetz was for several years in charge of the company's tool-room and light manufacturing operations.

C. R. Burt has resigned the position of superintendent of the Barber-Colman Co., Rockford, Ill., and becomes factory manager of the Russel Motor Car Co., Toronto, Ontario, Canada, September 1. E. W. Billings, formerly general foreman, succeeds Mr. Burt as superintendent of the Barber-Colman Co., and F. G. Hoffman will have charge of sales of small tools and the machine tool departments.

Prof. Albert Sauveur of Harvard University, Cambridge, Mass., has been awarded the Elliott Cresson gold medal by the Franklin Institute of the State of Pennsylvania, acting through its committee on Science and the Arts, in recognition of his numerous and important contributions to the science of metallography and the influence he has exerted in bringing this science into practical and useful application in the iron and steel industry.

Charles H. Moyer, for twenty years traveling manager of the George V. Cresson Co., Philadelphia, and of its successor, the Cresson-Morris Co., for the last three months, has resigned his position. Mr. Moyer, who is widely known as a specialist in power transmission machinery, was connected with the George V. Cresson Co. since boyhood and held various positions at the works before opening the New York office. He contemplates going into business as a special engineering representative and manufacturers' agent, with an office at 90 West St., New York City.

Dr. W. H. Tolman sailed for Europe July 29. The United States State Department has accredited Dr. Tolman as a delegate to the Tenth International Housing Congress which will meet at The Hague September 8, 1913. He is also the secretary of the American Section of the Congress. Dr. Tolman will go directly to London in the interest of the International Exposition of Safety and Sanitation to be held in New York City next December under the auspices of the American Museum of Safety; while in England he will seek to obtain exhibits, particularly such as will show the work done by the factory inspection section of the Home Office in the prevention of occupational diseases and industrial poisons.

Isaac P. Richards

Samuel Porcher has been appointed purchasing agent of the Pennsylvania Railroad system, succeeding Daniel S. Newhall, who died July 12 after having been in the company's service thirty-one years. Mr. Porcher is a graduate of the University of Virginia and entered the machine shops of the company in 1882. He went through a full shop course and was transferred from the mechanical engineer's office to the office of the superintendent of motive power in Jersey City in 1888. In that year he was appointed assistant engineer, motive power department, United Railroads of New Jersey Division, in which position he remained until 1894, when he was made assistant purchasing agent of the Pennsylvania Railroad Co.

Samuel S. Eveland of the Eveland Engineering & Mfg. Co., Philadelphia, Pa., owner of the Hunter and other tractor truck patents, covering the use of two-, three- and four-wheel tractors with fire apparatus, wagons, trucks, etc., has closed a contract with the Martin Tractor Co., Springfield, Mass., and has become identified with that company. The president of the Martin Tractor Co. is Harry G. Fiske of the Fiske Rubber Co. Under the agreement, all the patents of the Martin Tractor Co. and those transferred by Mr. Eveland are consolidated under one control. The Martin Tractor Co. will immediately erect a factory for the manufacture of tractor trucks for the trade. The Knox Co. of Springfield, Mass. will continue to make them under a license agreement.

* * *

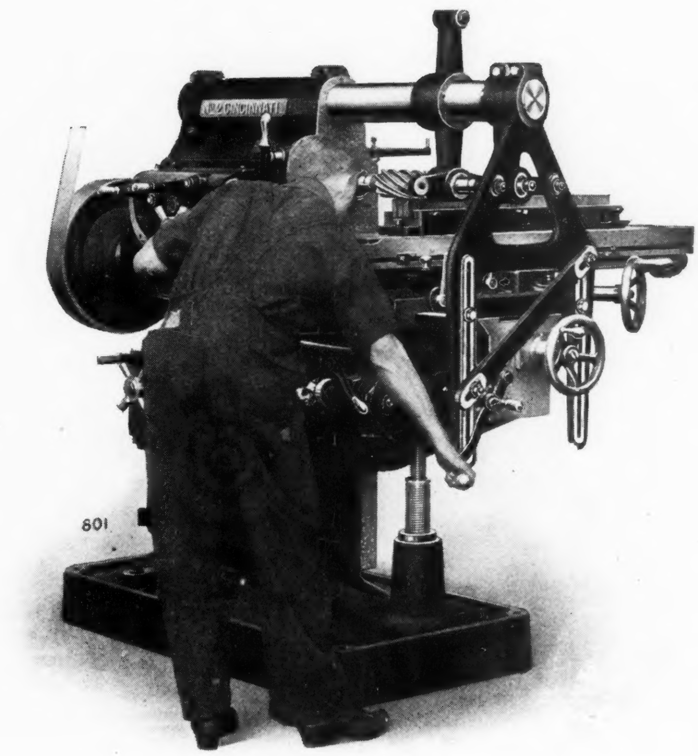
OBITUARIES

Isadore Van Huffel, who has been in the employment of the Dodge Mfg. Co., Mishawaka, Ind., for about thirty-five years, died August 4. For almost twenty-five years Mr. Van Huffel has had charge of the paint and oil department of this company. He was born November 19, 1842, in Belgium, and came to this country forty-one years ago. He resided in Mishawaka ever since his arrival in the United States.

ISAAC P. RICHARDS

Isaac P. Richards, president of the I. P. Richards Co., Providence, R. I., died July 18. Mr. Richards was born in Ashford, Conn., June 15, 1834. At the age of seven, he was put on a farm in Pomfret, Conn., where he worked for eight years for board and clothes. He received a country schooling by doing chores late at night. Later he worked on farms at various places in Connecticut, until at the age of seventeen, he went to Plantsville, working for the Plants Mfg. Co. Returning to the farm for a couple of years, he began, in 1853, to learn the machinists' trade in the shop of Paul Whitin & Son. In April, 1856, he finished his apprenticeship, during which he had received $2 a week, out of which he had paid $1.88 for board. He worked now for two years in Whitinsville, Mass., and in 1858 he went to Providence to work for W. T. Nicholson and later for J. R. Brown & Sharpe. He moved about during the next few years, and in 1864 went back to Whitinsville to take charge of the screw department. In 1867 he was granted a patent for a spindle boylster. In 1869 he patented an improvement in punches for iron and steel, and two years later he went to Providence to manufacture these punches in the machine shop of W. T. Nicholson. In 1885 he built his own shop at 23 Pemberton St., Providence, for the manufacture of punches and dies. The business was incorporated in 1908. The quality of the punches which Mr. Richards manufactured is well known all over the country. His motto was "Quality" and he wanted everybody to live up to it.

Conserve Energy



The "Setting Up" Position

All our levers are on this side where speeds and feeds are changed

ON all knee and column type milling machines the elevating shaft is at an angle on the left-hand side of the knee, because that is where the operator stands when "setting up" and adjusting. All the dials are also on this same side. From this position he can work the cross and vertical adjustments with his right hand and the table movement with his left.

This is especially important on those machines that run right handed.

We have grouped all our operating levers, feed and speed change levers, adjusting levers, indexes and dials on that side of the machine where they are within easy reach of the operator when "setting up." That is when he uses them. Later, when milling, he works back and forth with the table, clamping the work in front of the cutter and removing it after it has passed to the other side. He then steps to the quick return, brings the table back, and, on our machine, he chucks a new piece from his last position. He need not walk to the end of the table to operate the quick return and then back again, because our quick return wheel is in front of the saddle, in the most convenient place for returning the table with the least effort. And in addition to all this, our feed levers also reverse the travel; he engages the feed by setting the lever in the direction he wants to feed.

Another lever at the side of the knee enables him to work the machine from behind the table for end milling, boring, etc., doing easily large work of this character that other machines can't handle.

We gave these things special attention in all our designs, and have provided that handiness and convenience which conserve the energy of the operator and result in greater production.

The Cincinnati Milling Machine Company

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS: Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St. Petersburg. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London. Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. **CANADIAN AGENTS:** H. W. Petrie, Ltd., Toronto, Montreal and Vancouver. **JAPAN AGENTS:** Andrews & George, Yokohama. **CUBA AGENT:** Krajewski-Pesant Co., Havana. **AUSTRALIAN AGENTS:** Thos. McPherson & Son, Melbourne. **ARGENTINE AGENTS:** Robert Pusterla & Co., Buenos Aires.

COMING EVENTS

September 18-20.—Eighth annual convention of the Federation of Trade Press Associations in the United States, at the Hotel Astor, New York City. W. H. Ukers, chairman of the committee of arrangements, 79 Wall St., New York City.

October 7-10.—Convention of American Society of Municipal Improvements in Wilmington, Del. George H. McGovern, secretary, Chambers of Commerce, Wilmington, Del.

October 10-17.—Eighth annual foundry and machine exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. One hundred and eight concerns were represented in the exhibition held in Buffalo, N. Y., last year and over one hundred and twenty-five concerns have taken space for this year and two hundred are expected. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago, Ill.

October 13-17.—Annual convention of the American Institute of Metals at Chicago, Ill. W. M. Corse, secretary, Lumen Bearing Co., Buffalo, N. Y.

October 14-16.—Annual convention of the Allied Foundrymen's Association. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 19-25.—Seventh annual convention of the National Society for the Promotion of Industrial Education, in Grand Rapids, Mich. The convention promises to be the greatest yet held by the society in point of attendance, importance of questions to be discussed and interest in the work. C. A. Prosser, secretary, 105 East 22nd St., New York City.

October 20-26.—Convention of the American Mining Congress in Horticultural Hall, Philadelphia, Pa. James F. Callbreath, secretary, Munsey Bldg., Washington, D. C.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers. Headquarters Engineers Bldg, 29 West 39th St., New York City. Calvin W. Rice, secretary.

December 11-20.—First International Exposition of Safety and Sanitation under the auspices of the American Museum of Safety, 29 W. 39th St., New York City. Dr. William H. Tolman, director. Safety and health in every branch of American industrial life—manufacturing, trade, transportation on land and sea, business and engineering, in all of their subdivisions, will be represented at this exposition. Exhibits from Europe and other foreign countries will be admitted free of duty by special act of Congress. European employers have cut their accident and death rate in half by a persistent campaign of safety. There are twenty-one museums of safety in Europe, and all these will contribute to the American Exposition.

NEW BOOKS AND PAMPHLETS

Reinforced Concrete Wall Footings and Column Footings. By Arthur N. Talbot. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 67. Price, 50 cents.

Progress Reports of Experiments in Dust Prevention and Road Preservation, 1912. 51 pages, 6 by 9 inches. Published by the U. S. Department of Agriculture, Washington, D. C., as Circular No. 99.

Investigations of Detonators and Electric Detonators. By Clarence Hall and Spencer P. Howell. 73 pages, 6 by 9 inches. Illustrated. Published by Department of Interior, Bureau of Mines, Washington, D. C., as Bulletin 59.

First Series of Coal-Dust Explosion Tests in the Experimental Mine. By George S. Rice, L. M. Jones, J. K. Clement and W. L. Egy. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin No. 56.

The Determination of Internal Temperature Range in Concrete Arch Bridges. By C. S. Nichols and C. B. McCullough. 101 pages, 6 by 9 inches. Published by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 30.

Theory of Loads on Pipes in Ditches and Tests of Cement and Clay Drain Tile and Sewer Pipe. By A. Marston and A. O. Anderson. 181 pages, 6 by 9 inches. Published by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 31.

Legal Specifications for Illuminating Gas. By E. B. Rosa and R. S. McBride. 31 pages, 7 by 10 inches. Published by Department of Commerce, Washington, D. C., as Bulletin No. 14 of the Technologic Papers of the Bureau of Standards. S.W. Stratton, director.

Determination of Phosphorus in Steels Containing Vanadium. By J. R. Cain and F. H. Tucker. 11 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Bulletin No. 24 of the Technologic Papers of the Bureau of Standards. S. W. Stratton, director.

Logarithms for Beginners. By Charles N. Pickworth. 49 pages, 4¾ by 7¼ inches. Published in America by the D. Van Nostrand Co., New York City. Price, 50 cents.

This little book gives a more detailed and practical explanation of logarithms and their various applications than is to be found in most mathematical text-books. The present edition is the fourth, and a table of hyperbolic logarithms has been added which will make the work of still greater value.

The Boy Mechanic. 469 pages, 7½ by 9½ inches. 800 illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price $1.50.

This work for boys, amateurs and all interested in construction and operation of machinery, scientific apparatus, etc., was compiled largely from the "Popular Mechanics Magazine." Seven hundred articles tell how to construct wireless outfits, boats, camp equipment, aerial gliders, self-propelled vehicles, engines, motors, electrical apparatus, cameras and hundreds of other things. The book is one that will be highly appreciated by the average boy as a birthday or Christmas gift.

Journal of the Municipal School of Technology, Manchester. Vol. 6. Containing a record of investigations undertaken by members of the teaching staff and students of the school. Published by the University of Manchester, Manchester, England.

The volume contains, among other valuable contributions, a paper on cutting tools, by Dempster Smith, which will be found of interest to those concerned with the design and operation of machine tools. The paper reviews the experimental investigations of forces acting on cutting tools of the form best adapted for durability. It also reviews some durability experiments. The paper covers fifty-three pages of the volume and is illustrated with folding charts, diagrams and halftones.

The Gas Engine Handbook. By E. W. Roberts. 323 pages, 4¼ by 7 inches. 85 illustrations. Published by the Gas Engine Publishing Co., Cincinnati, Ohio. Price $2.00.

This is the seventh edition of a handbook which was first published in 1900. The new edition is entirely rewritten and the subjects are treated from the standpoint of the latest practice in this field. The book throughout is practical rather than theoretical in its nature. The principles of operation of the various cycles of gas engines are first dealt with, after which the gas engine fuels, the mechanism of the gas engine and the various details of gas engine construction are described. The book is divided into three parts, the first section being mainly descriptive, while the second part deals specifically with the design of gas engines, chapters being devoted to each detail of the engine. Besides the descriptive section and that on design, about fifty pages of the book are devoted to the operation and testing of gas engines, and suggestions are also given for selecting an engine to fit the requirements of the buyer.

NEW CATALOGUES AND CIRCULARS

Ohio Valley Pulley Works, Maysville, Ky. Card advertising "Limestone" pulleys.

T. W. G. Cook, 88-90 Walker St., New York City. Circular advertising presses, dies, molds and patterns.

Production Engineering Co., 1716 Spring Garden St., Philadelphia, Pa. Circular advertising structural steel column crane.

Rockford Iron Works, Rockford, Ill. Folder advertising high-duty Rockford punch presses and illustrating the company's patented automatic brake.

H. Bickford & Co., Lakeport, N. H. Circular illustrating and giving general dimensions of motor-driven boring and turning mills in from 4- to 7-foot sizes.

Adolph Muehlmatt, Fifth Ave. and Elm St., Cincinnati, Ohio. Circular of the "Rex" universal ball vise for tool-makers, die-sinkers, stamp-cutters, mold-makers, etc.

Sprague Electric Works of General Electric Co., 527-531 West 34th St., New York City. Bulletin of motor-driven exhaust fan outfits with direct- and alternating-current motors.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Bulletin E-29 (superseding E-24) and 34-B on Duntley electric grinders, heavy-duty portable type and "Chicago Pneumatic" power-driven compressors, respectively.

George Von Rottweiler, chief engineer, Western Metal Products Co., Inc., Waterloo, Iowa. Pamphlet entitled "Draftsmanship and Mechanical Engineering," advertising correspondence school course in mechanical drawing.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue K, 1913, on Brownhoist locomotive crane with grab bucket. The catalogue contains numerous illustrations showing the application of the crane in various industries.

James Rees & Sons Co., Pittsburg, Pa., builder of engines, boilers and steamboats. Catalogue of the various products of the company, showing interesting illustrations of the development of river steamboats in the United States.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 34R on enclosed self-oiling, single-stage, steam and belt-driven compressors. Also Catalogue No. 43 illustrating and describing "Rockford" railway motor cars.

National Tube Co., Frick Bldg., Pittsburg, Pa. Booklet on "Kewanee" pipe unions, hose unions, air pump unions, flange unions, union ells, union tees, boiler couplings, ball joints, boiler fittings, brass cocks, check valves, globe valves, etc.

Duryea Motor Co., Saginaw, Mich. Leaflet containing testimonials from various users of the company's product, and also a number of reprints from various publications bearing on the subjects of the two-cycle motor, air-cooling and similar features.

U. S. Electrical Mfg. Co., 459-461 East Third St., Los Angeles, Cal. Bulletin "A" illustrating and describing type "FR" constant speed polyphase induction motors from ¼ to 15 horsepower. Also circular showing in line engravings the design of the type "FR" motor.

Dodge Mfg. Co., Mishawaka, Ind. Catalogue D-Z 25 on the Dodge-Zimmer conveyor, intended for economical transportation of raw, finished and waste materials. The catalogue is illustrated with excellent halftones and line engravings showing many different applications of the conveyor.

Berger Mfg. Co., Canton, Ohio. Catalogue of sheet metal products including roofing, siding, eaves troughs, conductor pipe, gutters, ventilators, skylights, metal ceilings, metal furniture, metal lumber, metal stock-room equipment, cornices, finials, reinforcing and furring plates, metal lathes, metal shingles, tin plate, metal tile, etc.

Tate, Jones & Co., Inc., Pittsburg, Pa. Circular No. 142 entitled "Fuel Oil Data." The circular contains considerable information for those who use fuel oil, particularly for metal heating, tempering, etc. Much of the data is carefully tabulated, and a great deal of information is given on the heating values of various fuels.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Booklet illustrating and describing electrical equipment for automobiles. Folder of Westinghouse 3-inch meters. Pamphlet entitled "Small Motors," showing their application to washing machines. Circular illustrating and describing squirrel-cage induction motors.

General Electric Co., Schenectady, N. Y. Bulletins Nos. A4093, on Generators for Electrolytic Work; A4124, on Automatic Starters for Alternating-Current Motors; A4130, on Adjustable Speed Direct-current Motors; A4135, on Lightning Arresters for Electric Railways; and A4139, on Central Station Oil Switches of High Rupturing Capacity.

Atlas Ball Co., 203 Glenwood Ave., Philadelphia, Pa. Circular of Atlas ball gages for measuring internal diameters ranging from ¼ inch to 2 inches diameter. The gages consist of steel balls, guaranteed accurate within 0.0001 inch and electrically welded to suitable handles. These gages are furnished in various combinations according to the wants of users.

Michigan College of Mines, Houghton, Mich. Year book for 1912-1913 and announcement of courses for 1913-1914. The book, comprising 130 pages, gives a mass of information for prospective students, and a program for the year 1913 and 1914. Complete information is contained regarding admission to the college, either on certificate from accredited schools or by examination.

Lapointe Machine Tool Co., Hudson, Mass. Bulletin No. 13 illustrating and describing the Lapointe broaching machines, and giving, in addition, brief descriptions of work done on these machines, the descriptions being illustrated both with halftones and line engravings. Many interesting illustrations of broaching operations of difficult work are shown, and a table of dimensions of Lapointe standard cutter bars is included.

Garvin Machine Co., Spring and Varick Sts., New York City. Catalogue illustrating and giving the dimensions of wrenchless chucks. In addition, the catalogue contains a number of illustrations with accompanying description relating to the operation of Garvin turret machinery. The chucks are operated on two systems: compressed air and spring power. The air system is recommended as being the most powerful and convenient.

Suspension Roller Bearing Co., Sandusky, Ohio. Catalogue illustrating and describing Boyer suspension ball bearings. The catalogue contains a description of the method of construction of these bearings, calling attention to their advantages and the particular services for which they are suited. It also illustrates hangers provided with these ball bearings and gives tables and dimensions and load capacities of bearings for combined radial and thrust loads as well as for plain and grooved ball thrust bearings.

Standard Electric Tool Co., Cincinnati, Ohio. Bulletin U8, superseding Bulletin U7 on standard high-power universal portable electric drills operating on both direct current and alternating current. These drills can run from a lamp socket or power circuit, using either alternating or direct current of the same voltage. It is claimed that they operate satisfactorily on low frequency circuits from 0 to 60 cycles without any special feature or change in winding. These electric drills are furnished in seven sizes, having a capacity in steel ranging from ¼ inch to 1¼ inch, respectively.

Peck, Stow & Wilcox Co., Southington, Conn. Catalogue 10-A of P. S. & W. tinsmiths' tools and machines, comprising squaring shears, curved shears, slitting shears, scroll shears, parallel shears, circular shears, cornice brakes, folding machines, forming machines, brace and wire benders, grooving machines, turning machines, burring machines, wiring machines, elbow-edging machines, setting down machines, beading machines, swages, stovepipe crimpers and beaders, corrugating machines, gutter machines, double-seaming machines, elbow seam closers, tucking machines, punches, wire feed and cutter, tinners' hand shears or snips, stake-holders, stakes, shear-holders, vises, roofing tongs, cross-lock seamers, hammers, soldering coppers, etc.

TRADE NOTES

Benson Brothers, 51-53 Druitt St., Sydney, Australia, dealers in American tools, would like to receive catalogues from American machine tool builders who are not represented in Australia.

Ferracute Machine Co., Bridgeton, N. J., celebrated its semi-centennial August 16 by a garden party given by President Oberlin Smith and wife at their home "Lochwold" adjoining the works.

Goldschmidt Thermit Co., 90 West St., New York City, announces that the San Francisco office of the company has been removed from 432-436 Folsom St. to 329-333 Folsom St.